MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

VOL. LXXXV. FEBRUARY 13, 1925. No. 4

ANNUAL GENERAL MEETING.

Dr. J. L. E. DREYER, PRESIDENT, in the Chair.

The Minutes of the preceding Annual General Meeting were read and confirmed.

The Report of the Auditors of the Treasurer's accounts for the year 1924 was read, and is given on p. 301.

Short Addresses on the progress of Astronomy during the past year were delivered by Professor Eddington, Mrs. Maunder, Professor Milne, and Dr. Jackson. Professor Newall spoke on the forthcoming meeting of the International Astronomical Union at Cambridge.

The President then gave a short account of Tycho Brahe's Observations, his methods and results.

The President having appointed the Scrutineers, the Society proceeded to the ballot for Officers and Council for the ensuing year. The names of those elected are given on p. 391.

The thanks of the Meeting were given to the retiring Members of Council, and also to the Auditors of the Treasurer's accounts and to the Scrutineers of the ballot.

Rev. Robert Armstrong, The Manse, Edgworth, Bolton, Lancs;
George Elliott Barton, Gonville and Caius College, Cambridge;
Arthur Frederick Bennett, M.Inst.C.E., Haylings, Leiston, Suffolk;
Reginald Robert Samuel Cox, Lecturer in Mathematics, University of Sheffield;
Rev. John L. Gipprich, S.J., Director of the Observatory, Georgetown University, Washington, D.C., U.S.A.;
Edward Harrison, M.D., M.A., F.R.C.S., St. Leonards, Hornsea, near Hull;
Charles Hujer, R.N.C., University of Prague, and 26 Gloucester Road, London, N.W. 1;
C. A. Robert Lundin, Manager of Optical Dept., Alvan Clark & Sons, Cambridge, Mass., 173 School Street, Watertown, Mass., U.S.A.;
George Pearson, Observatory House, Calton Hill, Edinburgh;
Rev. Edward C. Phillips, S.J., Professor of Astronomy, Woodstock College, Woodstock, Md., U.S.A.;
Percy Raymond Portman, 26 Brunel Street, Burnley, Lancs;
Archie Clyde Schock, A.M., Professor of Mathematics and Astronomy, Central High School, Philadelphia, Pa., U.S.A.; and
Raymond Whitehead, B.Sc., Ivy Lea, Broad Road, Sale, Cheshire,

were balloted for and duly elected Fellows of the Society.

The following candidates were proposed for election as Fellows of the Society, the names of the proposers from personal knowledge being appended :—

Harold Lee Alden, M.S., Ph.D., Leander McCormick Observatory, University, Charlottesville, Virginia, U.S.A. (proposed by S. A. Mitchell);
Joseph Canon Boyce, Trinity College, Cambridge (proposed by H. Dingle);
Ernest Reginald Bryan, A.I.C.A., 145 Cromwell Road, S. Kensington, London, S.W. 7 (proposed by K. Pollock);
Rev. Evan Cruickshank, M.A., Drumtochty, Kincardineshire, N.B. (proposed by T. E. R. Phillips);
Alfred Edward Gaddum, 1 Catharine Road, Bowdon, Cheshire (proposed by A. E. Levin);
Thomas Kelsey, Morton, Gainsborough, Lincs (proposed by H. H. Cox);
Alexander Lorimer Kennedy, B.E., Chief Assistant, Adelaide Observatory, S. Australia (proposed by J. M. Baldwin); and
Raymond Streatfield, 42 Orrington Square, London, S.W. 3 (proposed by J. E. Littlewood).

Report of the Council to the Hundred and Fifth Annual General Meeting of the Society.

Progress and Present State of the Society.

	Patron	Institutional Member	Honorary Member	Fellows		Associates	Total
				Compounders	Annual Subscribers		
1923 December 31	1	1	1	227	633	48	910
Since elected	...	...	...	...	+41	...	...
Deceased	...	...	...	−6	−11	−1	...
Resigned	...	...	...	...	−11	...	...
Since compounded	...	...	...	+5	− 5	...	...
Removed from list	...	...	...	...	−10	...	...
1924 December 31	1	1	1	226	637	47	913

(Four Associates are also Fellows, and are therefore counted twice in the above table.)

Colonel Stratton's Cash Account as Treasurer of the Royal

RECEIVED.

	£ s. d.	£ s. d.
Received on account of Dividends:—		
£1,250 Metropolitan 3-per-cent. Stock (Tax free) ...	37 10 0	
£2,000 Swansea Corporation 3½-per-cent. Stock (Tax free)	70 0 0	
£2,287, 6s. 9d. East Indian Railway 3-per-cent. Debenture Stock	53 3 6	
£5,125 London Midland and Scottish Railway 4-per-cent. Debenture Stock	158 17 6	
£750 London Midland and Scottish Railway 4-per-cent. Consolidated Preference Stock	23 5 0	
£2,400 Gas Light & Coke Co. 3-per-cent. Debenture Stock	55 16 0	
£2,000 Commercial Gas Co. 3-per-cent. Debenture Stock	46 10 0	
£3,852, 12s. 6d. War Loan Inscribed 5-per-cent. Stock (Tax free)	192 12 6	
Interest on Deposit Account (proportion)	4 7 4	
Income Tax refunded £108 11 4		
Less allotted to Trust Funds ... 8 3 10		
	100 7 6	
Sale of Publications:—		742 9 4
History R.A.S.	103 5 0	
Monthly Notices, Memoirs, etc.	19 5 1	
Herschel Papers	12 0 0	
Reprints	78 13 6	
Per Wheldon & Wesley	215 17 1	
Miscellaneous Receipts:—		429 0 8
Sale of Photographs	57 14 0	
Postages repaid	6 17 3	
London Mathematical Society, for use of Rooms, etc.	30 0 0	
Use of Telephone	0 9 9	
Assistant Secretary, Pension premium	11 5 0	
Office of Works, Refund on advance payments for Fire Hose and Boiler Extension	35 12 4	
		141 18 4
Trust Fund Dividends:—		1313 8 4
£1,212, 13s. 3d. East Indian Railway 3-per-cent. Debenture Stock	28 3 10	
Income Tax on ditto, refunded	8 3 10	
£542, 18s. 2d. India 3½-per-cent. Stock (Tax free) ...	19 0 0	
£946, 6s. 11d. 5-per-cent. War Stock, 1929/47 (Tax free)	47 6 4	
Special Fund:—		102 14 0
Donations in 1924	47 9 0	
Interest on National War Bonds	50 0 0	
Interest on Deposit Account (proportion	6 12 5	
Received on account of Subscriptions:—		104 1 5
Annual Contributions for 1924	1025 6 0	
,, ,, ,, 1925–26, paid in advance ...	29 8 0	
Admission Fees (including 7 due in 1923)	98 14 0	
First Contributions (including 7 due in 1923) ...	73 10 0	
Arrears paid off:—		
7½ for 1921 ... ... £15 15 0		
23 for 1922 ... ... 48 6 0		
71½ for 1923 ... ... 150 3 0		
	214 4 0	
		1441 2 0
Compositions		61 19 0
Institutional Membership Fee (War Office, Geographical Section)		2 2 0
Balances, 1924 January 1:—		
Cheques outstanding, 1924 Jan. 1	2 0 6	
In hand of Assistant Secretary on Petty Cash Account	12 13 2	
At Bankers', on Current Account	485 5 7	
At Bankers', on Deposit Account (including £237, 7s. 11d., Special Fund)	391 3 0	
At Bankers, on "C" Account (Trust Funds) ...	68 19 5	
		960 1 8
		£3985 8 5

Examined and found correct.

(Signed) W. M. H. GREAVES.
HERBERT DINGLE.

1925 *January* 20.

Astronomical Society, from 1924 *January* 1 *to December* 31.

PAID.

	£	s.	d.	£	s.	d.
Assistant Secretary: Salary	225	0	0			
Clerk: Salary	150	13	4			
Assistant Secretary and Clerk for work for London Mathematical Society in 1923	10	0	0			
Porter and wife: Wages	139	3	0			
Bonus to Porter	10	0	0			
				534	16	4
House Duty	1	15	0			
Insurance	15	9	2			
Telephone	11	18	6			
Registration of Telegraphic Address	2	0	0			
Time Signal (2 years)	10	5	4			
				41	8	0
Postage, etc. (including postage of *Monthly Notices*, £80, 12s. 6d.)				126	10	1
Printing, etc.:—						
Monthly Notices (9 numbers)	974	17	11			
Geophysical Supplements, Nos. 4 and 5	113	19	3			
History of the R.A.S.	259	2	8			
Grove-Hills Library Catalogue	54	3	9			
Miscellaneous	60	16	6			
Reprints	99	10	0			
Photo-engraving	78	0	3			
				1640	10	4
Reproduction of Photographs for sale				53	14	3
Library:—						
Binding, etc.	11	16	6			
Equipment	11	17	10			
				23	14	4
Royal Society, half share of Profits on Herschel Papers	0	8	0			
Purchase of scarce numbers of *Monthly Notices*	5	7	6			
Purchase of Herschel Portrait	4	4	0			
Guarantee to *Journal of Scientific Instruments*	10	0	0			
Stationery and Office Expenses	29	14	3			
Coal, Gas, Electric Light	91	5	11			
House Cleaning, Laundry, etc.	17	1	2			
Furniture, Decorating, Fittings, and Repairs	381	18	4			
Miscellaneous Expenses	12	1	11			
Subscription to International Telegrams Bureau	1	7	9			
Pension Premium for Assistant Secretary	33	15	0			
Expenses of R.A.S. Meetings	20	5	10			
Expenses of Geophysical Discussions	6	19	2			
Expenses of L.M.S. Meetings	7	15	7			
				622	4	5
Bank Charges and Cheque-Book				1	4	0
				3044	1	9
Expenditure on Trust Accounts:—						
Turnor and Horrocks Fund } Library	16	3	10			
Harry Watson Fund ... }	45	4	3			
Lee and Janson Fund	6	0	0			
				67	8	1
Balances, 1924 December 31:—						
Cheques not yet credited	1	5	0			
In hand of Assistant Secretary on Petty Cash Account	22	13	2			
At Bankers', on Current Account, as per Pass Book	254	12	1			
At Bankers', on Deposit Account (including £341, 9s. 4d. Special Fund)	491	3	0			
At Bankers', on "C" Account (Trust Funds) ...	104	5	4			
				873	18	7
				£3985	8	5

REVENUE

	£	s.	d.	£	s.	d.
To General Expenditure as per Cash Account	3044	1	9			
,, Reserve for Accounts due but not presented	260	0	0			
	3304	1	9			
Less Provision for Accounts due 1923 now written back £500 0 0						
Less Special Liabilities shown in 1923 Balance Sheet, but included in 1924 Expenditure 36 11 0						
	536	11	0			
				2767	10	9
To 28½ Annual Contributions in Arrear written off ...	59	17	0			
,, 1 Admission Fee 1923 written off	2	2	0			
,, 1 First Contribution 1923 written off	1	1	0			
,, 13 Annual Contributions 1924 written off as per contra	27	6	0			
				90	6	0
Excess of Income over Expenditure, 1924	...		...	11	1	4
				£2868	18	1

ACCOUNT, 1924.

		£	s.	d.	£	s.	d.
By Subscriptions—							
489	Annual Contributions for 1924 (including 4 from Fellows elected 1924 January, and 1 Institutional Membership Fee)	1026	18	0			
8	ditto, paid in advance in 1922 and 1923, and now matured	16	16	0			
1	Part Subscription, 1924	0	10	0			
	ditto, outstanding	1	12	0			
115	Annual Contributions 1924, outstanding ...	241	10	0			
13	Contributions for 1924 due, but unpaid, in respect of Fellows resigned, died, or names removed, and written off per contra ...	27	6	0			
626					1314	12	0
,, 23	First Contributions, 1924, at 2 guineas ...	48	6	0			
17	ditto, at 1 guinea	17	17	0			
1	ditto, outstanding	1	1	0			
41					67	4	0
,, 40	Admission Fees, 1924	84	0	0			
1	ditto, outstanding	2	2	0			
41					86	2	0
5	Compounded since Election	...		...	61	19	0
,,	Sundry Debtors, 1924	...		...	77	19	2
,,	Dividends, Sales of Publications, and Miscellaneous Receipts, as per Cash Account	1313	8	4			
Less	Payments due in 1923, as per last Account £49 19 3						
	Income Tax repaid on 1923 Revenue 68 2 5						
		118	1	8	1195	6	8
,,	Income Tax deducted, but outstanding, 1924 April–December				65	15	3
					£2868	18	1

Examined and found correct.

(Signed) W. M. H. Greaves.
Herbert Dingle.

1925 *January* 20.

BALANCE SHEET,

LIABILITIES.

	£ s. d.	£ s. d.
1 Subscription 1925, paid in 1922	2 2 0	
12 Subscriptions 1925, paid in 1924	25 4 0	
2 Subscriptions 1926, paid in 1924	4 4 0	
		31 10 0
Sundry Creditors for Accounts due but not presented ...		260 0 0
Cash Balances (Income) due to Trust Funds—		
Turnor and Horrocks Fund	0 17 2	
Harry Watson Fund	41 13 5	
Hannah Jackson Fund	43 12 3	
Lee and Janson Fund	18 2 6	
		104 5 4
Trust Funds (Capital), as per contra		1,949 17 0
Special Fund—		
As at 1923 December 31	1,310 4 4	
Donations and Interest, 1924	104 1 5	
		1,414 5 9
General Fund—As at 1923 December 31	15,625 1 0	
Add—Excess of Income over Expenditure, 1924 ...	11 1 4	
		15,636 2 4
		£19,396 0 5

226 Compounders.

1924 *December* 31.

ASSETS.

	£ s. d.	£ s. d.
Sundry Debtors for Subscriptions in Arrear—		
14 for 1922	29 8 0	
44 for 1923	92 8 0	
115¾ for 1924	243 2 0	
1 First Contribution for 1924, outstanding ...	1 1 0	
1 Admission Fee for 1924, outstanding	2 2 0	
		368 1 0
Sundry Debtors, 1922	... ...	1 13 0
Sundry Debtors, 1924—		
Due for Publications sold (including Reprints) ...	34 4 9	
Due from Wheldon & Wesley for Publications sold during the last quarter of 1924	27 5 5	
Due for Photographs sold	14 1 0	
Due for Postages, etc.	2 8 0	
		77 19 2
Investments, General Fund, valued as on 1922 December 29		14,986 0 0
Investment of Special Fund, valued as at date of purchase		1,072 16 5
Investments of Trust Funds, valued as on 1922 December 29		1,949 17 0
Income Tax deducted, 1924 April-December		65 15 3
Sundry Balances—		
Cash at Bank on Current Account	254 12 1	
,, ,, Deposit (including Special Fund, £341, 9s. 4d.)	491 3 0	
,, ,, "C" Account (Trust Funds) ...	104 5 4	
Cash in hand of Assistant Secretary	22 13 2	
Cheques not credited, 1924 December 31	1 5 0	
		873 18 7
		£19,396 0 5

Astronomical and other Manuscripts, Books, Prints, Photographs, and Instruments.

Furniture, etc.

Stock of Publications and Photographs.

One Gold Medal.

Examined and found correct.

(Signed) W. M. H. Greaves.
Herbert Dingle.

1925 *January* 20.

INVESTMENTS, GENERAL FUND.

As at 1924 December 31.

£1250 Metropolitan 3-per-cent. Stock.

£2000 Swansea Corporation 3½-per-cent. Stock.

£2287, 6s. 9d. East Indian Railway 3-per-cent. Debenture Stock.

£5125 London, Midland, and Scottish Railway 4-per-cent. Debenture Stock.

£750 London, Midland, and Scottish Railway 4-per-cent. Consolidated Preference Stock.

£2400 Gas Light and Coke Co. 3-per-cent. Debenture Stock.

£2000 Commercial Gas Co. 3-per-cent. Debenture Stock.

£3852, 12s. 6d. War Loan 5-per-cent. Inscribed Stock.

Report of the Auditors.

We have examined the Treasurer's account of receipts and expenditure for the calendar year 1924, also the Revenue Account and Balance Sheet for that year, and have certified these accounts to be correct.

The balance in hand on 1924 December 31 amounted to £873, 18*s.* 7*d.* This figure includes £104, 5*s.* 4*d.* Trust Funds and £341, 9*s.* 4*d.* Special Fund.

The Balance Sheet shows that on 1924 December 31 the amount of the General Fund was £15,636, 2*s.* 4*d.*

The Revenue Account shows that the income for the year amounts to £2868, 18*s.* 1*d.*, and the expenditure to £2857, 16*s.* 9*d.* It is gratifying to observe that, as compared with the previous year, the sign of the balance has changed.

The Grove-Hills Special Fund at the beginning of the year amounted to £1310, 4*s.* 4*d.* During the year £104, 1*s.* 5*d.*, consisting of £47, 9*s.* donations and £56, 12*s.* 5*d.* interest, was added to this fund, the total on 1924 December 31 being £1414, 5*s.* 9*d.*

No investments have been made during the year.

It will be noticed that the expenditure on the printing of the *Monthly Notices* was £974, 17*s.* 11*d.* (for nine numbers), as against £827, 5*s.* 6*d.* (for eleven numbers) in 1923. This is to a large extent due to the fact that the size of the numbers has been unusually large during the last year.

The Grove-Hills Bequest of £250 received in 1923 has been spent in furnishing the Grove-Hills Library, preparing a catalogue, removing books, etc.

The books, instruments, and other effects appear to be in a reasonably good condition. There are still six books missing, as reported a year ago. The instruments lent in 1914 to the Eclipse Committee have now been returned, and are in good condition. The Assistant Secretary has continued the valuable work of rearranging the library.

A list has been laid on the table of the names of those Fellows who are in arrear for sums due at the last Annual General Meeting of the Society, with the amount due against each Fellow's name.

The certificates of railway and other stocks have been examined, and the stocks inscribed at the Bank of England verified.

On 1924 December 31 there were 115$\frac{3}{4}$ subscriptions for that year still unpaid.

We are indebted to the Assistant Secretary for the facilities that have been placed at our disposal during the Audit.

(Signed) W. M. H. Greaves.
Herbert Dingle.

1925 *January* 20.

Gifts to the General Funds of the Society.

The John Lee Gift: In 1836 John Lee, Esq., LL.D., gave the Advowson of the living of Hartwell; in 1844 he gave the Advowson of the living of Stone, Bucks. In 1879 these Advowsons were repurchased by his heir, Edward Lee, Esq., for £700.

The Lawson Bequest (1856): Henry Lawson, Esq., bequeathed to the Society the sum of £200, free of legacy duty.

The Carrington Bequest (1876): R. C. Carrington, Esq., F.R.S., bequeathed to the Society £2,000 Consols.

The Lambert Bequest (1877): C. J. Lambert, Esq., presented to the Society the sum of £500, free of legacy duty, being part of a sum of money bequeathed by his father, Charles Lambert, Esq., for scientific purposes.

The Knott Gift (1899): Mrs. George Knott presented to the Society the sum of £250, to defray the cost of printing *Memoirs*, vol. lii., containing the late Mr. Knott's Observations of Variable Stars.

The Peek Bequest (1904): Sir C. E. Peek bequeathed to the Society the sum of £200, as a contribution towards the expense of printing the Rousdon Variable Star Observations (*Memoirs*, vol. lv., part 1).

The McClean Bequest (1905): Frank McClean, Esq., LL.D., F.R.S., bequeathed to the Society the sum of £2,000, free of legacy duty.

The Farrar Bequest (1906): The Rev. A. S. Farrar, D.D., bequeathed to the Society the sum of £100, free of legacy duty.

The Brook Gift (1907): C. L. Brook, Esq., gave one-third of the cost of printing Pogson's Variable Star Observations (*Memoirs*, vol. lviii.).

The Gill Bequest (1914): Sir David Gill, K.C.B., F.R.S., bequeathed to the Society the sum of £250, in aid of Astronomical Research, in grateful remembrance of a like sum paid out of the funds of the Society in aid of his expedition to Ascension in the year 1877. In accordance with his wishes this bequest was expended to defray part of the cost of publishing vol. lxiii. of the *Memoirs*, containing the Theory of the Four Great Satellites of Jupiter.

The Parsons Gift (1922): The Hon. Sir Charles Parsons, K.C.B., F.R.S., gave to the Society £2,500 War Stock (1929–47), in memory of his father, the 3rd Earl of Rosse, who made the 6-foot Reflector, and who died 1867 October 31.

The Grove-Hills Bequest (1922): Colonel E. H. Grove-Hills, C.M.G., F.R.S., bequeathed to the Society, free of legacy duty, his collection of early Astronomical and Mathematical books up to the year 1700, together with a sum of £250 to cover the expenses incurred by the Society in connection with the books.

The Grove-Hills Special Fund: As already reported to the Society, the late Treasurer collected by his private efforts, with the approval of the Council, a Special Fund to meet the immediate financial difficulties of the Society. He aimed at securing £1,800, and up to the present the total amount received from all sources is £1,614, 5*s.* 9*d.*, of which £200 was transferred during 1923 to the General Fund to meet current expenditure, and £1,072, 16*s.* 5*d.* was invested in National War Bonds.

	£	*s.*	*d.*		£	*s.*	*d.*
1924 Jan. 1. Cash Balance of Fund	237	7	11	1924 Dec. 31. Cash Balance on Deposit	341	9	4
Donations in 1924 ...	47	9	0				
Interest on National War Bonds and Deposit Account ...	56	12	5				
	£341	9	4		£341	9	4

The following is the list of donors to this Fund in 1924:—

C. Brewitt-Taylor.
J. McD. Field.
W. Hall.
E. H. F. Lawrence.
J. H. Reynolds.

Trust Funds.

The Lee and Janson Fund: In 1834 John Lee, Esq., LL.D., gave £100, and in 1876 T. C. Janson, Esq., bequeathed £200, the interest to be given to the widow or orphan of a deceased Fellow. These amounts now stand in £334, 10*s.* 9*d.* East Indian Railway 3-per-cent. Debenture Stock.

	£	*s.*	*d.*		£	*s.*	*d.*
1924 Jan. 1. Balance of Fund	14	1	10	1924. Grants from Fund ...	6	0	0
1924. Dividends, East Indian Railway ...	10	0	8	1924 Dec. 31. Balance of Fund	18	2	6
	£24	2	6		£24	2	6

The Turnor Fund and the Horrocks Memorial Fund: In 1853 the Rev. Charles Turnor, M.A., bequeathed a sum of £500, which now stands in £464, 18*s.* East Indian Railway 3-per-cent. Debenture Stock. In 1876 the Society received a sum of £38, 15*s.*, the unexpended balance of a fund collected for the purpose of erecting a memorial in Westminster Abbey to Jeremiah Horrocks: to this the Society added the sum of £55, 15*s.*, and the whole now stands in £103, 6*s.* East Indian Railway 3-per-cent. Debenture Stock. The interest on these funds is to be used in the purchase of books for the Library.

	£	*s.*	*d.*		£	*s.*	*d.*
1924. Dividends, East Indian Railway ...	17	1	0	1924. Purchase of Books ...	16	3	10
				1924 Dec. 31. Balance of Fund	0	17	2
	£17	1	0		£17	1	0

The Harry Watson Memorial Fund: In 1920 Mrs. Watson presented to the Society the sum of £300 as a memorial to her late husband, Lieut.-Col. Harry James Watson, F.R.A.S., the interest on this sum to be used for the purchase of books for the Library, such books to be indicated by a special book-plate. This gift now stands invested in £542, 18*s.* 2*d.* India 3½-per-cent. stock. In 1923 Mrs. Watson bequeathed a further sum of £958, 17*s.* 0*d.* to the Society, which now stands invested in £946, 6*s.* 11*d.* 5-per-cent. War Stock 1929–47. The Council resolved that these two sums should together constitute a Trust Fund, to be designated *The Harry Watson Memorial Fund*, to be used for the purchase and binding of books.

	£	*s.*	*d.*		£	*s.*	*d.*
1924 Jan. 1. Balance of Fund	20	11	4	1924. Purchase of Books and Binding ...	45	4	3
1924. Dividends, India 3½ per cent.	19	0	0	1924 Dec. 31. Balance of Fund	41	13	5
Dividends, War Stock 5 per cent.	47	6	4				
	£86	17	8		£86	17	8

The Hannah Jackson (née Gwilt) Fund: In 1861 Mrs. Hannah Jackson (*née* Gwilt) gave £300 Consols, which now stands in £309, 18*s.* 6*d.* East Indian Railway 3-per-cent. Debenture Stock; the interest to be given in medals or other awards in accordance with the terms of the Trust.

	£	*s.*	*d.*
1924 Jan. 1. Balance of Fund	34	6	3
1924. Dividends, East Indian Railway	9	6	0
1924 Dec. 31. Balance of Fund	43	12	3

Celestial Photographs.

The following have been added to the list of Celestial Photographs reproduced by the Society for sale to the Fellows:—

R.A.S. Ref. No.

332. Neb. Barnard 72 Ophiuchi, 1921 July 4, 100-in., Mount Wilson.
333. Neb. Barnard 92 Sagittarii, 1922 June 22, 100-in., Mount Wilson.
334. Neb. Barnard 133 Aquilæ, 1921 July 3, 100-in., Mount Wilson.
335. Trifid Neb., M 20 Sagittarii, 1921 June 30, 100-in., Mount Wilson.
336. N. America Neb., south end, 1922 July 26, 100-in., Mount Wilson.
337. Neb. N.G.C. 4594, 1916 May 3, 60-in., Mount Wilson.
338. Field of Nebulæ in Perseus, 100-in., Mount Wilson.
339. Neb. N.G.C. 4647, 4649, 1920 Jan. 26, 100-in., Mount Wilson.
340. Neb. N.G.C. 3115, 1911 Dec. 25, 60-in., Mount Wilson.
341. Neb. N.G.C. 7217, 1913 Sept. 2, 60-in., Mount Wilson.
342. Moon, Region around Copernicus, 1919 Sept. 15, 100-in., Mount Wilson.
343. Moon, Eratosthenes to Plato, 1919 Sept. 15, 100-in., Mount Wilson.
344. Neb. N.G.C. 7635, 1920 Oct. 15, 60-in., Mount Wilson.

Publications of the Society.

During the past year vol. lxxxiv. of the *Monthly Notices* has been published, also *Geophysical Supplements*, Nos. 4 and 5, and *The Catalogue of the Grove-Hills Library*.

Obituary.

The Council regret that they have to record the loss by death of the following Fellows and Associate during the past year :—

Fellows :—*Allen Abraham.
John Jepson Atkinson.
William Frederick Caborne.
Arthur Dallas.
William Henry Finlay.
Thomas Frederick Furber.
†Arnaud de Gramont.
Arthur Hands.
Joseph Hough.
Henry T. C. Knox.
William Henry Maw.
Thomas K. Mellor.
Margaret Theodora Meyer.
Edward Prentice.
†Abel Pérez Sanchez.
E. B. Simpson-Baikie.
Hugh Walsham.
Associate :—Hugo Seeliger.

John Jepson Atkinson was born in Yorkshire in 1844 ; educated at Exeter College, Oxford ; went to the Bar ; married Isabella Foster of Apley Park in 1881 ; bought Cosgrove Priory, near Stony Stratford, in 1888, and resided there until his death on 1924 December 12. He was for more than thirty years a county councillor. His eldest son, a captain in the Royal Dragoons, was killed at Ypres in 1915. His widow, a second son (who served throughout the War) and two daughters, survive him.

Our Society owes an incalculable debt to some of its Fellows for whom astronomy has not been the business of their lives, nor even perhaps a primary interest, but who have been attracted by astronomers, and by whose friendship and companionship astronomers have gained, often in no small degree ; Atkinson was such a genial friend to astronomy and astronomers. He was chiefly a keen sportsman. He kept racehorses even when an undergraduate at Oxford ; and raced under the name of Mr. Doncaster. The name of the dearly loved eldest son he lost in the War, St. Leger, was a reminder of his birth on the day of that famous race. He was, moreover, as a young man a keen cricketer, a fast bowler for Yorkshire county. He was of an inventive turn, and some ideas he had for improving a gun brought him into association with the late Dr. A. A. Common. This led to his joining the Eclipse Expedition of 1896, of which Common took charge ; to his joining our Society, and its dining-club, of which he was a

* Died in 1922, but death not reported till 1924.
† Died in 1923, but death not reported till 1924.

devoted and much-valued member so long as his health permitted; and to his undertaking several other Eclipse Expeditions, to the delight of his companions. One of these was Sir Frank Dyson, who has given his personal reminiscences as follows :—

"Atkinson's introduction to astronomical circles dates from 1896, when he accompanied the large party of astronomers who went on the *Norse King* to Vadsö. He and I met first at the Royal Astronomical Society Club in 1900 January, a few months before the Eclipse of that year. An official expedition to Ovar near Oporto had been arranged, consisting of Christie, Davidson, and myself. We each had an instrument to take charge of, mine being two spectroscopes lent by Hills. So we very readily accepted an offer by Atkinson to accompany us as a volunteer observer. Our friendship began with this expedition. He shared in all the work of the unpacking, installation, and adjustment of the instruments, and on the day of the Eclipse gave the exposures for the spectra of chromospheres and corona, while I manipulated the changing of plates. Atkinson was the life of our party, keeping us all in good temper and good spirits in the small worries and difficulties incidental to Eclipse Expeditions. He evidently enjoyed the trip too, for the next year, when I asked him if he wouldn't come to the Eclipse in Sumatra, he delighted me by saying he should love to go if he could get leave from his duties in Northamptonshire as member of the county council. Happily he was able to make the necessary arrangements, and we set out in the middle of 1901 March in company with Professor and Mrs. Newall and a number of Dutch and American astronomers. At this Eclipse we were assisted by a small gunboat, the *Pigmy*, and, though I cannot speak too highly of the help given by officers and men, Atkinson's company and co-operation were invaluable. Living in this little ship, anchored just outside a reef surrounding the small island where our instruments were erected, each morning he and I at 6 o'clock went ashore and supervised building of huts and erection of instruments, and came back to the ship in the evening. The ship usually went away on Saturday to get provisions, water, etc., and returned on the Monday, leaving us with two marines to cook for us and assist in any way we wanted. After dinner we got into our hammocks and talked till we felt sleepy, Atkinson telling stories of his Oxford days, hunting adventures in America, or of his experiences as a barrister on circuit. No one ever had a pleasanter companion on an Eclipse Expedition or one who turned his hand more readily to taking the clock to pieces and cleaning it or whatever wanted doing. He was more distressed than I was when we thought the day was going to be cloudy. Not till the Eclipse had been satisfactorily observed did he take a holiday. Then he went away for a few days on an expedition after a tiger, where he had no luck but found the experience very exciting he said. He returned by the time I had finished developing the photographs, and helped me pack up and dispatch the instruments to England. The time I spent with him in Sumatra was one of the most delightful experiences of my life. He went and helped me at another Eclipse Expedition in Tunis in 1905, when we were guests for

a time of Lord Beatty, then Captain Beatty of the *Suffolk*. In the spring of 1912 I went at his invitation to see another Eclipse. He took his two-seater car from Southampton to Havre, and we went leisurely up the Seine in time to see the short Eclipse at St. Germains, and back again *via* Dieppe, and along the coast to Havre, taking a trip by boat to see the Bayeux tapestry. In the autumn of the same year he accompanied Eddington and Davidson to Brazil, where the fortune of weather was against them.

"This was his sixth and last Eclipse Expedition. He frequently attended the meetings of the Society and sometimes those of the British Association. In later years, when he was hardly fit to travel, he would come to London to see his old friends. No one ever made less of his own illness. I shall always remember with gratitude the help he has given me, and think of him as the kindest and cheeriest comrade in expeditions which are not free from worry and anxiety, but which his companionship made the pleasantest of experiences."

The value of such a man is not conveyed by records of facts, but by the testimony of his friends. Another of those who knew him well was Father A. L. Cortie, of Stonyhurst, who has written this:—

"The chief trait in the character of J. J. Atkinson was his exceeding kindliness of disposition, which made him friends with everyone. For instance, on the Eclipse Expedition to Sumatra, the sailors of the man-of-war conveying the astronomers were so captivated by his open-hearted geniality, that they invited him to lie full length on the deck with his head over the hatch, to get the first whiff from the rum cask when it was broached for the crew. He appears, too, to have been a great favourite with an important local chief. In fact, in whatever society he might be found, his attractive personality gained for him the goodwill of everybody. He was greatly esteemed by the Fathers at Stonyhurst.

"The death of his elder son, killed in the War, affected him very deeply, but he bore his loss with exemplary resignation and courage, and was sincerely grateful for any expressions of condolence and sympathy. Captain St. Leger Atkinson commanded the 6th Signalling Troop of the 3rd Cavalry Brigade of the 6th Division, and was killed in France early in 1915. At the memorial service, held in Cosgrove Church, he said: 'There is not a real man here, who will not wish for such an end as his, and who does not thank God with me for having given me such a son.' For to those who knew him intimately he was a man of sincere faith, and of deep religious spirit.

"In early life he had been an adept in all forms of sport—cricket, hunting, racing. His prowess in cricket was well known in Yorkshire, and he kept a racing stable, even when he was an undergraduate at Oxford. A valuable painting, which was given to him in lieu of a racing debt, now hangs in the main corridor at Stonyhurst.

"The people about Cosgrove Priory idolised him, and gentry and labourers gathered together at his funeral to express their esteem and regard for one who had endeared himself to all their hearts. He is buried in the cemetery attached to the parish church of SS. Peter and Paul at Cosgrove. He died on 1924 December 12, aged eighty years."

The testimony of Professor R. A. Sampson, Astronomer Royal for Scotland, loses nothing of its emphasis or effectiveness by its opening reference to the exceptional nature of the relationship:—

"I find myself very little inclined to express in ordinary terms what Atkinson represented to us. He met us on a side which has nothing to do with the usual scientific categories. A sportsman, a country gentleman, bred on the classics at Oxford, and retaining no little interest in them, with a very extensive knowledge of people of all stamps, he ended by adopting astronomers. Frankly, I accepted that as evidence of his shrewdness. It was no doubt the sporting side of the science that led him in—eclipse-hunting in queer parts of the world. To picture him in his element I recall the Eclipse of 1905 at Sfax in Tunis, a festival dinner with tables set in the open street, the company British, French, and Italian astronomers, with the officers of H.M.S. *Suffolk*, and Arab dignitaries from the native town, and Atkinson pouring out a tremendous fire of chaff, and asking in vain for the French for 'Keep the ball rolling.' But while he entered into that game like the splendid old boy he was, and though he never became an astronomer in any technical sense, the science meant a real interest to him. He knew extraordinarily well what was what, in this world, and his curiosity in matters of ideas, in the people that propounded them, was the sign of his active, joyous mind searching for food where he knew he would find it good.

"Add that he was one of the most constant of friends, and that it was impossible to be dull in his company."

He was elected a Fellow of the Society on 1899 Feb. 10.

H. H. T.

Captain Warren Frederick Caborne, son of Warren Caborne, Esq., Apparitor-General of the Diocese of Rochester, was born at Danbury, Essex, on 1849 July 5. He entered the Mercantile Marine in 1865 as a midshipman on board the frigate-built East Indiaman "Hotspur." In 1875 he obtained command of a sailing-ship, and later he commanded several ships. He had some thrilling experiences at sea. In 1867 October he was in the "Blenheim" when it was dismasted during a cyclone in the Bay of Bengal, and he was in the Banka Straits at the time of the great eruption that wiped out Anjer and submerged Krakatoa in 1883.

In 1879 he joined the R.N.R., and he served with distinction on several of His Majesty's ships. These services were recognised by the conferring upon him in 1897 of the companionship of the Most Honourable Order of the Bath.

On the outbreak of the Great War in 1914, although beyond the age limit of recall, he volunteered his services to his country. These were accepted, and he was appointed an inspector of steel in the Naval Ordnance Department. He was awarded the Royal Naval Officers' decoration, and on the conclusion of the war he was promoted on the retired list to the rank of Captain, R.N.R.

His interest in the sea is shown by various offices he held, *e.g.* Director of the Sailors' Home, Gravesend; Deputy Chairman of the

Shipwrecked Mariners' Society, and Hon. Treasurer to the St Andrews' Waterside Mission to Sailors. He held the following Government appointments: Nautical Assessor for formal investigations into Shipping Casualties, 1898–1914; Inspector to the Board of Trade for Marine Inquiries; Nautical Assessor to H.M. Court of Appeal (Supreme Court of Judicature) 1903–1908; Nautical Assessor to H.M. Privy Council.

Captain Caborne, during his sailing-ship days (having early served under the late Captain H. Toynbee), devoted much attention to Meteorology. He contributed several papers to the *Journal of the Royal Meteorological Society*, and gave lectures on Meteorology. He was Secretary of the Meteorological Society, 1909–1915.

In 1897 he married Mary Lilian, elder daughter of the late Sir T. William Boord, Bart., and is survived by an only son.

He died on 1924 June 15.

He was elected a Fellow of the Society 1887 April 10.

William Henry Finlay was born at Liverpool on 1849 June 17, and educated at Liverpool College School. He proceeded to Trinity College, Cambridge, graduating 33rd Wrangler in 1873. In the same year Mr. Finlay was appointed First Assistant at the Royal Observatory, Cape Town, when Mr. Stone, who succeeded Sir Thomas Maclear, was His Majesty's Astronomer. Mr. Stone's directorate is chiefly remarkable for the enormous amount of arrear reductions of transit observations which he accomplished, and for his well-known 1880 Cape Catalogue of Stars. In all this work Mr. Finlay took his full share.

As an observer he was very zealous in the observation of comets and occultations of stars. He independently discovered the great comet of 1882, and also one, which bears his name, in 1886, and he undertook the task of computing its elements as well as those of several others. Perhaps in astronomical circles he will be best remembered by his excellent Star Correction Tables, which exemplify the clear grasp he had of his subject, and the orderly practical habit of his mathematical mind. It was the ability to apply his mathematical knowledge to practical affairs that will make his death so great a loss to education in South Africa.

In addition to his purely astronomical work, Mr. Finlay took an active part in the geodetic work which Sir David Gill, who succeeded Mr. Stone, accomplished during his directorate. He was the principal observer in the longitude operations for connecting Aden with Cape Town, and on his voyages to and from Aden he took advantage of the short stoppages of the steamer at Delagoa Bay, Quilimane, Mozambique, and Zanzibar to determine local time at these places with portable instruments, and to exchange time-signals with Cape Town. These observations and the resulting longitudes were published in the *Monthly Notices*. He also determined the longitude of Aberdeen Road station while observing the transit of Venus in 1882.

In 1887 he undertook the discussion of the tidal records of Table Bay and Algoa Bay, and the result of his analysis, which is published in the *Journal* of the South African Philosophical Society, is still the basis for all tidal predictions at those ports.

In addition to these activities, he became the General Secretary of the South African Philosophical Society from 1881 to 1887, in which year he was elected President. He was also a member of the Cape Meteorological Commission.

When the staff of the Royal Observatory was reorganised in 1897, Mr. Finlay was appointed Chief Assistant, but owing to ill-health he was obliged to retire on pension the following year. He spent several years in England, where he completely regained his health, and upon his return to South Africa he took up the work of teaching, a task for which he was eminently suited. When Professor Williams, of the Rhodes University, Grahamstown, left South Africa to take part in the Great War, Mr. Finlay took his place as Professor of Mathematics and Surveying, and he remained there at work, after Professor Williams had returned, to within a few days of his death.

He died at Cape Town on 1924 December 7, leaving a son and five daughters.

He was elected a Fellow of the Society on 1873 November 14.

[The Council are indebted for the above obituary to the *South African Survey Journal.*]

Thomas Frederick Furber was born in England on 1855 May 13. In 1869 he entered the Survey Branch of the Lands Department of Australia, and throughout his life he remained an outstanding figure in connection with the higher branches of surveying in Australasia. At the age of 26 he became a member of the Licensed Surveyors' Examination Board, and he remained a member of this Board till his retirement ten years ago. He was employed in the Trigonometrical Branch of the Survey, becoming Chief Computer in 1890 and Director in 1904. For many years he was lecturer in Geodesy and Astronomy in the University of Sydney. In 1882 he went with Mr. W. J. Conder to Lord Howe Island to observe the transit of Venus.

Mr. Furber was responsible in large measure for the accurate survey of a considerable portion of New South Wales, and later he selected various portions of the country to be triangulated.

He was not only energetic and conscientious in the discharge of his public duties, but he was also most faithful and devoted to his profession. He held the highest ideals, and strove to improve the standard of accuracy in survey work.

Mr. Furber died on 1924 October 7, and left a widow, three sons, and a daughter.

He was elected a Fellow of the Society on 1896 April 10.

[The Council are indebted for the above information to *The Surveyor.*]

Arthur Hands, L.R.C.P., M.R.C.S., was born at Walsall in the year 1851. He was educated at the Grammar School in that town, and afterwards at Birmingham University. In 1874 he commenced to practice as a doctor at Heath Town, a suburb of Wolverhampton.

In the course of a few years he became Medical Officer of Health for the district, and he held this position for nearly thirty-three years. His professional duties prevented him from devoting much time to astronomical work, but he was an ardent student of many branches of science, particularly geology, on which subject he was a local authority, and as a writer and lecturer he was in great demand and was deservedly popular. Soon after resigning his public work at Heath Town he removed to Tettenhall, a district on the other side of the town, where he hoped to have more time for the study of science. Early in 1924 he began to exhibit symptoms of failing health, and after a painful illness he died on 1924 September 18.

He married in 1901, and he leaves a widow and a son.

He was elected a Fellow of the Society 1899 January 13.

Joseph Hough, who died at Codsall Wood, Staffordshire, on 1924 November 14, was born at Leeds in 1837. He left school at an early age and became an apprentice in Fairbairn's Engineering Works. While there he used every opportunity for study and he attended evening classes at the Leeds Mechanics' Institute. After a fellow apprentice had once pointed out the Plough, the love of astronomy developed it and lasted to the end of his life. In 1859 he was appointed astronomer to the second Lord Wrottesley, a Past President of the Royal Society and also of the Royal Astronomical Society, and at that time President of the British Association, and he had charge of the Wrottesley Observatory and Library until after the death of Lord Wrottesley in 1867.

In 1869 he went to Sidney Sussex College, Cambridge, where he was soon elected a scholar. In 1872 he went as Science Master to Rossall School, and in 1874 he was elected Headmaster of Burnley Grammar School.

After his retirement, Hough lived in his country home near to the Wrottesley Observatory and devoted himself to study and coaching, being especially interested in helping those who were born in humble circumstances. He was a staunch churchman, and for many years he was a member of the Lichfield Diocesan Council. A man of much learning and of great humility, he was blessed with an unusually happy temperament, and to the end of his long life he retained the joyous spirit of youth, and his keen interest in scientific studies and in all branches of sport.

He married in 1875 Harriet, second daughter of the late S. Hickman, Esq., of Oaken, and he is survived by his wife and his three sons and three daughters.

He was elected a Fellow of the Society on 1873 December 12.

William Henry Maw was born at Scarborough on 1838 December 6, and was the only child of his parents. His father, William Mintoft Maw, was a captain in the Merchant Service, and both his grandfathers were captains in the Royal Navy.

Mr. Maw received his early education at Sykes' School, a private school at Scarborough. Here he formed a great friendship with the

sons of Dr. Harland, two of whom in later life were the founders of the well-known shipbuilding firm of Harland & Wolff at Belfast. In 1853 his father died at sea, and he and his mother were left very badly off. His mother died shortly after.

The boy's mind was early turned to mechanics and engineering, and in 1855 March he was taken on at the Stratford works of the Eastern Counties' Railway. At first he was in the smith's shop in the carriage and wagon department and soon after in the locomotive department. He appears to have been studious, for at this period he devoted his spare time to drawing at the Mechanics Institute, and thus qualified himself to give occasional assistance in the drawing-office of the Railway Company. He thus became an excellent draughtsman, and was thought so highly of by the Company that in 1859, at the age of 21, he was appointed head of the drawing-office of the locomotive and engineering department. In this position he remained till 1865, when he left the then Great Eastern Railway to join Mr. Zerah Colburn on the formation of the new journal *Engineering*. His long connection with this paper as one of the editors, from this time until the day of his death, is probably unique in the history of journalism.

Mr. Maw's activities in mechanical engineering began when he was quite a young man. While at Stratford he designed the locomotives for the East Indian Railway, and it is noteworthy that these were the first outside cylinder engines placed on an Indian railway. In a report on the locomotives exhibited at the 1862 exhibition Mr. Maw wrote the section on Valve Gears, which is recognised to-day as a classic on the subject. Beside the enormous labour entailed by editing a journal like *Engineering*, Mr. Maw had an extensive practice as consulting engineer in connection with engine and boiler construction and the design of workshops, particularly in designing and laying out the printing works of newspapers, such as *The Daily Telegraph*, *The Field*, *The Queen*, and others.

Constantly active in his profession, and endued not only with extensive mechanical and engineering knowledge, but with very sound common sense, Mr. Maw's services to the advancement of those sciences were fully recognised throughout the country. In 1863 he was elected President of the Civil and Mechanical Engineers' Society. In 1901 he was President of the Institution of Mechanical Engineers, and in 1922 he was chosen President of the Institution of Civil Engineers. At this Institution he delivered the "James Forrest" lecture on many engineering problems. This subject was followed up in his Presidential Address in 1922, when he treated again of the unsolved problems of engineering. "The remarkable thing about this presidential address was the detailed knowledge it showed of recent engineering developments, whether in connection with special alloys, X-ray investigations, steam-turbine practice, or reduction gearing. For such an address to have been prepared, unaided as it was, by a busy man in his eighty-fourth year, was evidence of an energy and a living interest in a wide variety of subjects which might well be envied by most younger men."*

Notwithstanding these many claims on his thought and energies,

* *Engineering*, 1924.

Mr. Maw devoted his leisure to astronomy. In 1887 he built an observatory at his house in Addison Road, in which he established a 6-inch equatorial refractor by Cooke. In this year he began the series of micrometric measurements of double stars, which he continued for over twenty years, and these were published in five memoirs of the *R.A.S.* Later on, in 1896, he erected at his house at Outwood, Surrey, the fine 8-inch equatorial refractor by Cooke, which had formerly belonged to the Rev. W. R. Dawes. His observations with both telescopes were mainly on the Struve double stars, and the comparison with other observers, as shown in Mr. Lewis's memoir on these stars, shows that the observations were made with refined accuracy.

In 1892 Mr. Maw was elected on the Council of this Society, and remained a constant attendant at its meetings till 1919, when he retired. During this period he was Treasurer from 1900 to 1905, when he was elected to the chair of the President, which he occupied for two years. His treasurership was marked by the introduction of a system for the reduction of composition fees according to years of Fellowship. As President he delivered two addresses, on presenting the Gold Medal to Professor Campbell in 1906, and a similar presentation to Professor Ernest Brown in 1907.

Mr. Maw was one of the founders of the British Astronomical Association in 1890, of which there was no more devoted member. For many years he was Treasurer, and for two years President. The great success that has attended that association is very largely due to his unvarying help and his wise counsels.

In 1909 Mr. Maw was honoured by the University of Glasgow by receiving the degree of LL.D., *honoris causa*. On that occasion it was stated on his presentation to the Vice-Chancellor: "It is fitting that the University, situated in what has not inaptly been termed 'the Metropolis of Mechanical Engineering,' should recognise the great services which Mr. Maw has rendered to the advancement both of pure and applied science by admitting him to its roll of honour." In 1923 his portrait, painted by Mr. Hall Neale, was presented to him by the Institution of Civil Engineers.

He was a member of the Board of the National Physical Laboratory and of many scientific societies; and his services were constantly sought on numerous committees connected with engineering, and he took an active part during the War on committees in connection with the ministry of munitions.

Dr. Maw was of a most gentle, amiable nature, of unbounded good humour, and always helpful in giving wise and sensible advice. He rarely missed attendance on the many committees of which he was a member, and he had a deep sense of duty and its responsibilities.

In many respects the life of Dr. Maw is noteworthy. Left an orphan at the age of 16, with scanty means, without influence, and without the advantages of higher education, he nevertheless raised himself by his own efforts and industry to an honourable position which made him a leading authority on mechanical engineering and brought him eventually the high distinction of presiding over the two great engineering institutions of this country.

In the last year or two of his life his health caused anxiety which put some restraint upon his energies, but he continued in active harness until his last illness, when he passed away at his house in Addison Road on 1924 March 19, at the age of 85 years, thus terminating a long life of great and abiding usefulness.

He left a widow and a family of three sons and five daughters; his widow, however, survived him only six months, as she died on September 11.

He was elected a Fellow of the Society on 1888 December 14.

E. B. K.

Margaret Theodora Meyer was the elder daughter of the Rev. Theodore Meyer, and was born in Ulster. She was educated at the North London Collegiate School for girls, and entered Girton College, Cambridge, as a scholar in 1879, taking honours in the Mathematical Tripos in 1882. She was Mathematical Mistress at Notting Hill High School until 1888, when she returned to Girton as Resident Lecturer in Mathematics. In 1901 she became Director of Studies, and she remained at Girton until the last year of the War, when she assisted in the calculating section of the Air Department. From 1919 on she coached pupils at University College, London, but was gradually giving up this work, and she was looking forward to building a cottage in Cambridge when she met her death suddenly on the evening of Sunday, 1924 January 27. She was cycling and collided with a motor bus, her death being instantaneous. She was present on January 11 at the meeting of the Royal Astronomical Society previous to her death. She was interested in astronomy, mountain climbing, and cycling, but her chief interests were connected with the College which she served for thirty years with zeal and devotion. For the College Chapel she herself carved the panels, or directed students in the carving. She has bequeathed to the College a collection of mathematical books and £2000, "the interest to be used for the encouragement of the study of mathematics, and to be given, at the discretion of the governing body, either to a student in her second or third year, or to one who has taken mathematics and intends to do mathematical research"; also £1000 to the College for general purposes.

She was elected a Fellow of the Society on 1916 February 11.

A. S. D. M.

Edward Prentice was born on 1864 June 20. He was educated at Wickham's Preparatory School, Worthing, and at Winchester College, where he became Captain of Sixes and Prefect.

On leaving Winchester he took up the business of paper-making, first at Whatman's Paper Mills at Maidstone, and subsequently at Carshalton and London. He was also connected with the electrical business, and joined the firm of Pyke, Harris & Co. at Westminster. About 1910 he visited Ceylon and the Malay Straits to investigate the possibilities of rubber plantations. On the outbreak of the War he undertook various duties connected with war service, and was engaged in munition and recruiting work at Wimbledon, Norwich, and Winchester.

For several years he resided at Ashtead, where he took up the study of astronomy. As showing his keenness about the subject, it may be mentioned that he went through a private course of mathematics in order that he might be the better equipped for his work in this field, and subsequently threw himself with great energy and assiduity into the study of the phenomena of long-period variables. He was much interested in the division of these stars into two groups according to the harmonics of their light curves, and also in the problems connected with the variation in their periods, publishing papers on these subjects in the *British Astronomical Association's Journal*, 32, 134; and in *Monthly Notices*, 82, 134, and 83, 377.

At the time of his death he was busily engaged in an investigation which he hoped might lead to further results of interest and value. He was also a practical observer of variable stars and used a $9\frac{1}{4}$-inch reflector belonging to a friend, but his chief astronomical work was on the theoretical side.

For some time he served on the Council of the British Astronomical Association, and in 1923 October he was appointed Secretary.

In private life he was a good friend to all who knew him, and a thorough sportsman, being fond of cricket, tennis, hunting, and shooting. For some years he was Secretary of the Leatherhead Golf Club.

He was taken ill only about a week before his death. A chill led to pneumonia, and although this was successfully overcome he collapsed from heart failure and died on 1924 February 28.

He was elected a Fellow of the Society on 1919 April 11.

T. E. R. P.

Hugh Walsham was born at Islington in 1853. He was educated at King's College School and then at Caius College, Cambridge. He was also a student at St. Bartholomew's and at the Great Ormond Street Hospital for Children, and he became M.D., F.R.C.P. He is best known for his pioneer work, begun as early as 1896 on the application of X-rays to the diagnosis of intrathoracic disease. In 1903 he was awarded by the Royal College of Physicians the Weber Parkes Prize and first medal for research work on tuberculosis. At the meeting of the British Medical Association in Birmingham in 1911 he was President of the Radiology Section, and he was Vice-President of the Radiology Section of the International Congress of Medicine in London in 1913. Dr. Walsham published *Stereoscopic Skiagraphy in Diseases of the Chest*, 1899, and with Harrison Orton *The X-Rays in the Diagnosis of Diseases of the Chest*, 1906, as well as numerous papers in the professional journals. He was Consulting Physician to the City Chest Hospital and consulting Radiologist to both St. Bartholomew's and King Edward VII. Sanatorium, Midhurst.

His chief recreation was the study of astronomy especially solar spectroscopy.

He married Amy, daughter of S. Bannister of Coventry, who survives him. They had no family.

Dr. Walsham did not escape the penalty paid by most of the early X-ray workers who failed to realise the risks they ran. A corre-

spondent writes of him: "With ready self-forgetfulness he discounted the loss of hands in the largeness of his heart and of his desire to help and heal. It was a very patient and heroic ending to a noble and heroic life." He died 1924 April 13.

He was elected a Fellow of the Society 1914 April 8.

Hugo von Seeliger was born at Bielitz-Biala, Austria, on 1849 September 23. He was educated at the universities of Heidelberg and Leipzig. From 1873–77 he was Observer at Bonn Observatory, taking part in the observations of the zone of the A. G. Catalogue and in the Transit of Venus expedition to the Auckland Isles. After an interval spent as Privat-dozent in Bonn and Leipzig he became Director of Gotha Observatory in 1881. A year later he was appointed Professor of Astronomy and Director of the Observatory at Munich. He was subsequently offered the Directorships at Potsdam and Vienna, but declined them and remained at Munich for the rest of his life. He was President of the Astronomische Gesellschaft for 24 years from 1897–1921.

Seeliger was a great teacher. His published contributions to astronomy are not very widely read; they are for the most part buried away in the publications of the Munich Academy; they are too lengthy and formal to please an English reader; and it is not easy to get at the gist of his results. But fortunately his influence on the progress of astronomy is not limited to the written word, and a general knowledge of what he was able to contribute has been disseminated in other ways. During his forty years of office, he made Munich into a great centre of astronomical training, and many of his students now active in astronomical research testify to the inspiration they received from him. He had not much personal acquaintance with foreign astronomers, and it is perhaps not easy for us to understand the high reputation he held in Germany; but there is no misdoubting the testimony of such a man as Schwarzschild, who always spoke with the greatest admiration of his former teacher and considered him the inspirer of much of his own best work.

Seeliger's chief researches, extending from 1884 to 1911, relate to the distribution of the stars, and the extent of the (local) stellar system. His name stands out prominently in the rather barren period just before the modern many-sided attack on the problems of the stellar system began. His earlier work related chiefly to counts of stars of the Bonn Durchmusterung, and its southern continuation, and their reduction to a true magnitude scale. His results were, for many years, the standard statistics in this subject, and provided material for studying the dependence of star density on galactic latitude and longitude, and the falling off of the star-ratio for fainter stars. In 1898 he published a mathematical theory of these statistics, showing that important conclusions as to the actual distribution of the stars in three dimensions could be deduced. He seems to have been the first to develop the mathematics of the subject, beyond the crude and obvious stage, and to formulate and treat the integral equations which are now well known. It was already clear, that the stars could not form a

uniform distribution extending to an infinite distance; the problem was to determine how fast the density faded away with increasing distance. Nowadays it is usual to introduce data as to mean parallactic motions and the dispersion of individual parallaxes about the mean value in order to help out the star-counts in an investigation of this kind; but we owe to Seeliger the theorem, that it is theoretically possible to determine the law of decrease of star-density from star-counts alone (provided only that the usual assumption is made that the same luminosity-law holds in all parts of the system). By this method he arrived at definite estimates of the extent of our star-cloud in different directions. It was a great satisfaction to him that when Kapteyn's mean parallaxes were published some years later, they fitted in closely with his results, and confirmed the dimensions which he had found solely from star-counts. He deduced from this agreement that the absorption of light in space must be very small—about $\frac{1}{3}$ of a magnitude in 4000 parsecs. It seems to be a weakness in most of this work that no estimate of probable error is given; and the mathematical solution is so complicated that the reader cannot supply an estimate, since he has altogether lost track of the particular statistical character, responsible for the result. Seeliger insisted, also, that the star density does not fade away continuously, but after diminishing for a great distance drops abruptly to zero; it is difficult to persuade oneself that the evidence for this boundary to the system is strong. The most convenient account of Seeliger's mature conclusions is contained in *Munich Sitzungsberichte* for 1911, pp. 413–461.

Perhaps the neatest of Seeliger's minor contributions was his test of Maxwell's theory of Saturn's rings proposed in 1893. In looking at a cloud of small particles illuminated by the Sun, some particles will send no light to us because they are occulted, others because they are eclipsed by particles in front of them. If Saturn's ring is really composed of small particles its albedo should be greatest when the Sun, Earth, Saturn are in a line, because then the occultations and eclipses coincide; it should diminish on each side of opposition as the overlap of eclipses and occultations becomes less and less. A long series of photometric observations by Müller showed that the brightness changed according to Seeliger's formulæ, and thus confirmed the theory that the rings were composed of small particles. Seeliger attached the more importance to this test because he was a critic of Maxwell's dynamical theory of the rings and was dissatisfied with its soundness.

Among his miscellaneous contributions we may mention the discovery of a dark component perturbing the motion of the double star ζ Cancri. At the present day his name is most often mentioned in connection with his explanation of the motion of the perihelion of Mercury and other residuals of the inner planets as due to the mass of the zodiacal light. He deduced the necessary density and extension of zodiacal matter. We conjecture that there was a connection between this research and his study of Saturn's ring and possibly also of the absorption of light in space, for he seems to have been particularly interested in cosmical dust-masses. His results are appreciated by non-relativists and relativists alike; the former consider that his hypothesis disposes of the

necessity of amending Newton's law; the latter think that there is no difficulty in showing that the high density assigned to the zodiacal matter is impossible, and that the conclusion disposes of the hypothesis by a *reductio ad absurdum*. In any case by ascertaining exactly what would be required to account for the anomalous motion of Mercury on Newton's theory without upsetting the other planets, Seeliger has clarified the ground of combat. He himself was an uncompromising opponent of Einstein's theory. Indeed in his latter years he seems to have had little sympathy with the new ideas growing up in physics and astronomy. His writings do not give the impression of a stalwart conservative, and he could speculate on the nature of Novæ as rashly as the rest of us. But he was evidently a man not easily moved in his opinions, and new proposals were regarded chiefly as a challenge to his keen critical faculties.

Circumstances in Germany after the War prevented him from taking the rest he desired, and in spite of advancing years and failing health he had to remain at his post. Three months before his death, his 75th birthday was made the occasion for celebration, and a Festschrift containing articles by 36 astronomers was presented to him. The distribution of the contributors was international, and the collection bears witness to the widespread desire to do honour to one of the chief pioneers in the modern study of stellar distribution. He died on 1924 December 2.

He was elected an Associate of the Society on 1892 November 11.

A. S. E.

Proceedings of Observatories.

The following reports of the proceedings of Observatories during the past year have been received from the Directors of the several Observatories, who are alone responsible for the same.

Royal Observatory, Greenwich.
(*Director, Sir Frank Dyson, Astronomer Royal.*)

The weather conditions, especially during the second half of the year, have been very unfavourable, and in consequence the number of observations has fallen below the usual.

Transit-Circle.—The number of transits observed during the year was 7500, including 127 of the sun and 101 of the moon. A reversion-prism eye-piece was frequently employed; it shows the bisection-error to be very small for most of the observers. Shorter bearing surfaces for the Y's of the transit-circle were introduced in March, and appear to be working satisfactorily.

The first Greenwich Catalogue for 1925·0, consisting mainly of stars in the list prepared by Dr. Backlund and Mr. Hough, is printed.

Altazimuth.—This instrument has been kept in the prime vertical throughout the year for observations of stars in Boss's Preliminary General Catalogue of magnitude 5·4 or brighter, and between the limits 11° 41′ N. and 50° 0′ N. declination. 2812 observations were obtained on 85 nights. As far as observations go at present there appears to be a correction of about +0″·4 to Boss's declinations.

Cookson Floating Zenith Telescope.—This has been used for determination of the variation of latitude. The number of plates taken was 215. The measurement is well in hand, and the results will be communicated to the Society in March.

Equatorials.—The occultation disappearances of three stars by the moon have been observed, and the reappearance of Mars on November 5. The Transit of Mercury (egress) was observed on May 7. Observations of comets have been made photographically by Mr. Merton with the 30-inch reflector or the Astrographic equatorial, and visually by Dr. Crommelin with the Sheepshanks equatorial, as follows :—

	No. of Phot.	Nights Visual.
Comet 1924 *a* Reid	1	...
,, 1924 *b* Encke	6	1
,, 1924 *c* Finsler	...	6
,, 1924 *d* Wolf	1	...
Baade's planet T. D.	6	3

Where it seemed desirable the results were at once communicated to Professor Strömgren.

28-*inch Refractor.*—During the year 636 observations of 400 double stars were made. Arranged according to separation, they are :—

Under 0″·5	33 stars.
0″·5 – 1″·0	99 ,,
1″·0 – 2″·0	131 ,,
Over 2″·6	137 ,,

A number of observations and drawings of Mars were made by Dr. Steavenson with this instrument during the last opposition.

Thompson Equatorial.—During the year 947 successful plates for parallax have been taken, and 932 have been measured. A list of 52 parallaxes was communicated to the Society and published in November. In addition, 115 plates have been measured for the proper motion in right ascension and 287 for the proper motion in declination of the parallax stars relatively to the comparison stars.

With the 30-inch reflector 43 plates have been taken for the determination of "effective wave-lengths." These are measured, thus completing the area within 9° of the pole.

In addition, 23 plates for adjustments have been taken and a number for comets, etc., already referred to.

Photographs of the selected areas giving the magnitude down to $13^{m}\cdot0$ to $14^{m}\cdot0$ have been taken with the 26-inch refractor for Zone 15°, half of Zone 30°, and parts of Zones 45°, 60°, and 75°. A large part of this is ready for the printer. It is proposed to finish this piece of work with the Astrographic telescope.

Astrographic Equatorial.—The determination of proper motions by comparison with earlier plates has been continued. The number of photographs taken is 89, the number measured is 44. Zone 65° (*i.e.* Dec. 64°–66°) is completed, and one-third of Zone 67°.

Photoheliograph.—Photographs of the sun were obtained on 252 days at Greenwich and 332 days at the Cape. On 6 days only photographs were not taken at either Observatory, and on 5 of these days photographs were obtained at Kodaikánal. Measurement and reduction is completed to September 25.

The Thompson photoheliograph, returned from Russia, was mounted on May 26. One-third of the photographs at Greenwich were taken with this instrument. It is used on days of clear skies and good definition, but the smaller Dallmeyer instrument is more convenient for snatching a photograph on a cloudy day.

The mean daily spotted area, corrected for foreshortening, is approximately 245 millionths as compared with 55 millionths in 1923. The minimum of solar activity was near the middle of 1923, spots putting this a few months earlier, and faculæ a few months later.

Clocks and Time-Service.—A new clock has been obtained from the Synchronome Company. The installation consists of a free-pendulum master clock working in conjunction with a slave clock as designed by Mr. Shortt. It was mounted on November 21, and its initial performance has been very satisfactory.

The time-service by wire to the G.P.O. has been carried on as in

previous years. In addition, suitable apparatus has been fitted for the transmission of time-signals to the British Broadcasting Company every half-hour. Greenwich time is usually broadcasted by the Company at 13^h, 16^h, and 21^h 30^m.

The wireless time-signals from Paris, Nauen, Bordeaux, and Annapolis have been recorded by a syphon recorder operated by means of an oscillating valve relay system. Failure to record the European signals is very rare. The Annapolis signals have been recorded on 188 days.

Printing.—The volume for 1922 and the Meridian Catalogue for 1925·0 are printed, and a large part of the proofs of the volume for 1923 have been read and returned to the printers.

Abinger Magnetic Station.—Reference has not generally been made in the Annual Reports to the Society of the magnetic and meteorological observations carried on at the Royal Observatory. It may be of interest to mention that the electrification of the Southern Railway in the neighbourhood of Greenwich makes necessary the transference of magnetic observations to a site much more distant from artificial electric disturbances. Two assistants are now permanently installed at Abinger, and magnetic observations are being made there of similar character to those previously made at Greenwich. The observations at Greenwich are being continued for comparison with Abinger till the electrification is completed.

Personal.—Mr. Cullen was promoted to the higher grade of junior assistants on September 1; Mr. Finch was appointed junior assistant on March 13; Mr. Merton has been working at the Observatory as a volunteer assistant from July 2, and is continuing his researches on comets. Dr. Jackson attended the British Association at Toronto, and took the opportunity to visit a number of American and Canadian observatories; Mr. Greaves attended the meeting of the International Geodetic and Geophysical Union at Madrid; Dr. Lundmark and Mr. Asklöf worked at the Observatory for about six weeks in the summer; Messrs. Gorakh Prasad, Aiyar, Mosharrafa, and Madwar were also here for shorter periods studying various branches of the work of the Observatory.

Royal Observatory, Edinburgh.

Close attention has been given to time determination, both with the Transit Circle and by the daily comparison with the microchronograph of the three principal clocks Riefler No. 258, Shortt, and Leroy No. 1230.

A new clock Shortt No. 4, purchased for the Observatory, was set up in 1925 January, and is now being rated.

A large number of stellar spectra have been taken with the Cooke 6-inch photo-visual telescope and reproduced with the Koch microphotometer. A paper containing a discussion of the results obtained, and giving the effective temperatures of 64 stars, was communicated to the Society in 1925 January.

In connection with this, laboratory work on the density of photographic images has been pursued.

Observations with the reconstructed solar spectroscope have been continued, plates being taken for the determination of the solar rotation.

The remeasures of the magnitude of stars in the Perth astrographic plates have been continued. The question of the publication of the measures is still under consideration.

The new installation for the observing and recording of wireless time-signals has worked satisfactorily. Signals from Paris, Lyons, Bordeaux, Nauen, Annapolis, and Greenwich are regularly taken.

With the equatorials some occultations have been observed, and preparations were made to observe the recent partial eclipse of the sun, but cloud prevented anything of importance being done.

The seismological and meteorological observations have been carried on.

Messrs. Gorakh Prasad and R. Madwar have been working at the Observatory as research students.

Royal Observatory, Cape of Good Hope.
(*Director, Mr. H. Spencer Jones, H.M. Astronomer.*)

Reversible Transit-Circle.—The observations of the list of stars selected from Boss's *Preliminary General Catalogue* were continued throughout the year. This programme of observation, commenced in 1918, is now nearing completion. A number of miscellaneous observations of occultation stars, heliometer comparison stars, and standard stars and Jupiter comparison stars were also secured. The observations during the year comprise:—

Observations of Right Ascension:—

Meridian transits	7893
Determinations of collimation	107
,, ,, level	424
,, ,, azimuth	106
Observations of meridian marks	1000

Observations of Zenith Distance:—

Determinations of Zenith Distances	8115
,, ,, runs	398
,, ,, nadir	378
,, ,, flexure	56

Heliometer.—Observations of the major planets at their oppositions have been continued. An extended series of evening and morning observations of Mars were secured round about opposition with a view to deriving the solar parallax. Observations of a pair of standard stars were secured with each set of Mars observations. The positions of the comparison and standard stars which were employed have been derived from observations made during the year with the reversible transit-circle. This series of observations will also furnish accurate positions of the planet.

The following observations were secured :—

Opposition of Neptune	.	78	obs.	in	distance	on	7	nights.
„ „ Saturn	{	60	„	„	„	„	8	„
	{	12	„	„	position angle	„	3	„
„ „ Jupiter	{	32	„	„	distance	„	6	„
	{	32	„	„	position angle	„	6	„
„ „ Mars	{	394	„	„	distance	„	43	„
	{	396	„	„	position angle	„	43	„
„ „ Uranus		36	„	„	distance	„	6	„

Victoria Telescope and Astrophysical Laboratory.—The telescope was in use on 189 nights during the year, principally in conjunction with the four-prism spectrograph and short camera for radial velocity determinations. The short camera was used on 165 nights, 288 star spectra being secured. The long camera was in use on 10 nights, when 28 spectra of Procyon and 11 of the components of α Centauri were taken.

The spectrograph was dismounted from July 14 to August 5 and replaced by the photographic breech end. During this period 41 plates of Jupiter's satellites were secured on 10 nights at the request of Professor de Sitter. The 1924 opposition being a favourable one for determining the inclinations and nodes of the satellites, each plate included, in addition to 6 exposures on Jupiter, 2 exposures on a pair of standard stars, and two trails of the planet taken with the clock stopped, to provide accurate means for the determination of the orientation. The positions of the two standard stars were determined with the reversible transit-circle, 20 observations of each star in declination being secured in order to provide a very accurate value of the declination difference of the pair.

409 plates of stellar spectra were measured for radial velocity, including plates measured in duplicate.

Work on the orbits of 8 spectroscopic binaries is well advanced, and others of long period are under regular observations.

In the laboratory investigations on the spectra of germanium, chlorine and tin have been in progress. Papers dealing with the spectrum of germanium and large line displacements in the spectra of germanium and chlorine have been communicated to the Society.

The Astrographic Telescope.—The following plates have been taken with this instrument :—

Cape Astrographic Zones ($-42°$ to $-45°$)	342	plates	with	1365	exposures.
Comet Reid 1924	19	„	„	20	„
Comet Finsler 1924	2	„	„	4	„
Opposition of Mars	182	„	„	635	„
Mars—standard areas	38	„	„	76	„

The fields of the Cape Astrographic Zones were photographed through the glass with a view to determining the proper motions by comparison with the plates of the original series. The measurement

of the plates secured is in hand, but has been temporarily stopped in order to complete the measurement of the Mars plates.

The photographs of Mars were secured during opposition concurrently with the heliometer observations for the determination of the solar parallax and for comparison with the heliometer results. An adjustable rotating sector was used to reduce the magnitude of the planet, and an absorbing filter was employed to cut out the longer wave-lengths and to bring the refrangibility of the light from the planet into approximate agreement with that of the comparison stars.

The duplicate measurement, by H.M. Astronomer and Dr. Halm, of the Mars plates is nearing completion.

Photoheliograph.—Daily photographs of the sun to supplement the Greenwich series have been continued throughout the year. In all, 688 photographs were secured on 333 days.

Visual observations for zero, to supplement the photographic observations, were secured weekly throughout the year from January 10.

All original negatives taken previously to December 4, and duplicates taken up to November 20, have been forwarded to Greenwich.

Occultations.—Twenty-three separate records of occultations of stars by the moon have been secured, viz. :—

Disappearances	at dark limb . . .	14
,,	,, bright ,, . . .	1
Reappearances	,, dark ,, . . .	7
,,	,, bright ,, . . .	1

The observations of occultations secured during the years 1880 to 1922 have been discussed. The errors of the tabular mean longitude during this period and of the tabular longitudes of the Moon's perigee and node have been derived. The eccentricity of the Moon's orbit, the coefficient of the principal term of the parallactic inequality and the semi-diameter of the Moon were also determined. The value of the solar parallax which resulted from the parallactic inequality was $8''{\cdot}805 \pm 0''{\cdot}005$, and for the true semi-diameter of the Moon the value $15'\ 32''{\cdot}70 \pm 0''{\cdot}04$ was derived.

A summary of the results has been communicated to the Society.

Milne-Shaw Seismograph.—Daily records have been obtained throughout the year. The records secured are sent regularly to the University Observatory, Oxford, for investigation.

Current Reductions.—(*a*) All meridian observations up to 1924 October 27 in R.A., and to 1924 November 18 in Dec., have been reduced to exhibit apparent places. Mean places have been formed up to 1924 May 2 in R.A., and to 1923 May 11 in Dec.

Star corrections have been examined up to 1924 June 27. Ledgers of results of current meridian observations have been made to 1922 November 15.

(*b*) A catalogue of proper motions of the stars, other than Boss stars, contained in the *Cape Fundamental Catalogue*, 1912–16, has been compiled and sent to the printer.

(*c*) The observed and tabular distances and position angles resulting

from the observations of Mars secured with the heliometer have been formed, and the observations of the standard stars reduced. The tabular right ascension, declination, and parallax of the planet at the times of the astrographic observations have been computed.

(*d*) The equations of condition resulting from the occultations of stars observed at the Cape during the years 1880 to 1922 have been transformed into a form enabling corrections to the orbital elements of the Moon to be derived. Hansen's tabular positions of the Moon have been reduced to Brown's theory. A copy for press of the full results, with a discussion, has been prepared and sent to the printer.

(*e*) The derivation from the observed diameters and standardisation to the Cape South Polar Sequence of the photographic magnitudes of the C.P.D. stars brighter than 9th magnitude, which are contained in the C.A.Z,, has been completed and discordances examined. The copy for press is in course of preparation.

Publications.—Cape Independent Day Numbers, 1925, has been published. *Cape Independent Day Numbers*, 1926, has been passed through the press

The *Cape Astrographic Zones*, vol. viii. ($-48°$), has been passed for press to R.A. $14^h\ 50^m$., and for revise to $19^h\ 50^m$. The whole of the proof-sheets of this volume have been received.

The whole of the proof-sheets of the Catalogue of Proper Motions of Stars, not in Boss, in the *Cape Fundamental Catalogue*, 1912–16, have been checked and sent for revise. The revised sheets up to R A. $0^h\ 50^m$ have been passed for press.

Miscellaneous.—The time-signal and meteorological services have been maintained as usual. A new Dines pressure tube anemograph, provided by the Meteorological Department, has been installed, the records given by the old anemometer having become unsatisfactory.

Cambridge Observatory.
(*Director, Professor A. S. Eddington, F.R.S.*)

The measurement and discussion of the proper motions of faint stars has been continued. Seven more regions have been fully reduced, bringing the total to seventeen. The results are similar to those described last year and show clearly the motion of the distant stars in the two star-streams. Of particular interest are the results obtained for the open cluster Messier 35 and its surroundings: it is believed that these show definitely that the cluster has an absolute proper motion of $1''$ per century.

With the Sheepshanks telescope 66 plates have been taken, of which 28 were "through the glass" for comparison with plates at an earlier epoch, and 28 were photographs of Kapteyn areas. The transit of Mercury on May 7 was observed.

The Director was on leave of absence in America for five months, from August to December, and visited the Observatories of Victoria, Flagstaff, Mount Wilson, Mount Hamilton, and others.

Solar Physics Observatory, Cambridge University.
(Director, Professor H. F. Newall, F.R.S.)

Spectroheliograph.—Photographs of the sun's disc in K_{232} light were obtained on 100 days (previous year, 102); and photographs of the prominences at the sun's limb were obtained on 85 days (previous year, 91).

The revival of disturbance, mainly about the solar belt from $+20°$ to $+25°$, with a few minor features at higher latitudes to $+35°$, indicates that the minimum of solar activity occurred during the early part of 1924.

For the year 1923 October 1 to 1924 September 30, the Director of the Kodaikánal Observatory has sent 315 spectroheliograms showing the sun's disc in K_{232} light.

A second paper by Mr. Butler, dealing with the distribution of bright masses of calcium flocculi, has been published in the *M.N.*, **84**, 134. The results confirm the conclusion mentioned in the previous paper as to the general longevity of the flocculi, and also indicate the existence of movements of considerable magnitude.

Study of Sun-spot Records and Prominences.—The observations made at Mount Wilson in the autumn of 1923 show that the magnetic polarities of bipolar groups in high solar latitudes in the new cycle are reversed, relatively to the polarities of such groups throughout the previous cycle. The characteristic features, in regard to area and proper motion, of notable pairs of spots in the two 11-year cycles, 1902–12 and 1913–23, were examined by the Director with the assistance of Mrs. Beech. The results were summarised in a paper communicated to the Society in 1924 May (*M.N.*, **84**, 528). The distribution in solar longitude and latitude of outbursts of spot-groups is now being examined by the Director and Mrs. Beech.

Mr. Moss has completed his tabulation of the distribution of the prominences at the sun's limb for the years 1904 to 1923, derived from the daily records obtained at Kodaikánal, many of them received in MS. through the kindness of Dr. Royds.

Solar Rotation.—The conditions of the sky during the summer months were even more unpropitious than last year for securing observations for the spectrographic determination of the solar rotation.

Stellar Spectra.—A list, compiled by Mr. Baxandall, of the absorption bands, both of known and of unknown origin, which occur in various celestial spectra, was communicated to the Society in June and published in the *M.N.*, **84**, 568.

The study of the difficult spectrum of *β Lyrae* has been continued by Mr. Baxandall, who has measured some of the earlier Cambridge spectra (1898 and 1910) of the star, for inclusion with the results derived from more recent Cambridge spectra (1921), and from the Allegheny spectra (1907).

He has also measured a number of the early plates in the Cambridge series that relate to stars that have been regarded as possible binaries, by reason of suspected variation in radial motion. The special stars

selected for this purpose were taken from table ii. of the Third Catalogue of Spectroscopic Binary Stars, compiled by J. H. Moore, and published in the *Lick Observatory Bulletin*, No. 355, **11**, 141.

Since last year's report the following papers have been published by Mr. E. A. Milne: (1) "An Astrophysical Determination of the Average Life of an Excited Calcium Atom" (*M.N.*, **84**, 354), and (2) "The Maxima of Absorption Lines in Stellar Spectra, II." (with Mr. R. H. Fowler) (*M.N.*, **84**, 499).

Meteorological Physics.—Mr. C. T. R. Wilson has continued his observations relating to the electric fields of thunderclouds and shower-clouds, mainly with the object of improving the methods of studying the sign and magnitude of the vertical potential gradients and currents below the centres of such clouds.

To throw light upon the behaviour of raindrops and cloud particles in the strongest parts of the field of a thundercloud, experiments were carried out in collaboration with Professor G. I. Taylor on the deformation and bursting of soap bubbles in an electric field. The results have been communicated to the Cambridge Philosophical Society.

The acceleration of β-particles in strong electric fields such as those of thunderclouds, has been discussed in another paper communicated to that Society.

Investigations on the tracks of ionising particles by the cloud method have been continued.

Staff.—Mr. E. A. Milne resigned his post as Assistant Director in 1924 September on accepting a post as Lecturer on the staff of Trinity College, Cambridge. He has since been appointed to the chair of Applied Mathematics in the University of Manchester.

Mr. J. A. Carroll, Sidney Sussex College, has been appointed Assistant Director in his stead.

Mr. C. T. R. Wilson has been appointed Jacksonian Professor of Natural Philosophy.

Dunsink Observatory.
(*Acting-Director, Mr. Charles Martin.*)

The time-service to Dublin has been continued as in previous years, the meridian circle, in conjunction with the Paris time-signals, being used to determine mean time.

The Observatory has been used mainly for teaching purposes, students are given a day each week for instrumental instruction, and any clear evening for night work.

The work of repairing the estate walls was continued. It is hoped that during the coming year the instruments will be in better order.

Durham University Observatory.
(Director, Mr. Harold Thomson.)

The weather during the year was extremely unfavourable, but over 600 observations of long period variable stars were obtained by Mr. Sargent with the 6·4-inch Peek Equatorial, 32 maxima and 15 minima being observed.

The observations have been communicated to the variable star section of the B.A.A.

Observations of Venus have been carried out and a few occultations have been observed.

The year's rainfall was 28·7 inches or 17 per cent. in excess of the average for Durham, rain falling on 203 days.

The usual meteorological records have been kept and communicated to the Meteorological Office.

Liverpool Observatory, Bidston.
(Director, Mr. W. E. Plummer.)

The routine work of the Observatory has been carried on as in previous years, and to this it is unnecessary to allude further.

The effort to make the Observatory of use in other directions than that of astronomy has so far progressed, that the Tidal Institute has erected in the Observatory a tide-predicting machine, constructed by Messrs. Kelvin, Bottomley & Baird of Glasgow, which gives the integrated effect of 26 components In addition, Professor Proudman and Dr. A. T. Doodson have introduced some novelties by which the machine registers chronographically the time at which the tide reaches definite heights.

A new seismograph, to replace that erected in 1915, has been generously provided by Mr. J. J. Shaw. Electrical illumination has been provided, an enlarged time-scale gives greater accuracy in reading the seismogram, and increased delicacy in the moving parts is secured.

A class for instruction in surveying and railway construction under the charge of Professor Perrott has been for some time inadequately accommodated in the Observatory. It is now proposed to provide additional facilities in order to afford opportunities for the formation of an advanced class in geodesy.

Norman Lockyer Observatory, Salcombe Hill, Sidmouth.
(Director, Major W. J. S. Lockyer, M.A., Ph.D.)

The usual routine of photographing the spectra of stars with the 12-inch McClean prismatic camera for the determination of spectroscopic parallaxes has been continued. Many spectra of bright line stars, *o* Ceti, and other stars of special interest have been taken with the larger dispersion of the Kensington 9-inch prismatic camera. Photographs have also been taken of the star-fields surrounding these objects,

with a Zeiss triplet lens of 4-inch aperture, which is mounted between the tubes of the 10-inch and 9-inch telescopes. Successful observations have been made on 136 nights, and 625 negatives have been obtained during the year.

The determination of spectroscopic parallaxes has been continued. The parallaxes of 100 B-type stars have also been published, and a further list is nearing completion. An investigation is also being carried out on the Mount Wilson method of treating these stars.

The work on bright line stars has been continued, and a paper giving a first account of these observations has been published. These stars have all been rephotographed during the last summer and autumn, and the work is still in progress for the detection of any changes in the spectra. The intensity changes noted in the spectrum of ϕ Persei have led to a special series of photographs being taken, and a discussion of these is in course of preparation.

A series of observations of o Ceti was carried out during the two periods of maximum brightness in 1924 January and December, and a paper has been published describing the results obtained during the January maximum.

An addition to the Observatory equipment has been made in the form of an instrument for obtaining widened enlargements of stellar spectra, embodying the principle of the clepsydra, and devised by the Director. An account of the construction and use of this instrument has been communicated to the Society.

The Observatory is thrown open to the public every Wednesday afternoon, and the number of visitors who attended during 1924 was 333.

The Observatory has sustained the loss of its caretaker, Mr. E. C. Lake, who had served since its foundation in 1912. He died in May, and has been succeeded by Mr. J. Boot. Mr. W. B. Rimmer, who had been temporarily appointed second assistant, has been appointed second assistant to the new Australian Commonwealth Observatory at Canberra. He terminated his appointment at this Observatory in November.

The annual general meeting of the Norman Lockyer Observatory Corporation was held on June 3.

Radcliffe Observatory, Oxford.
(Director, Mr. H. Knox-Shaw, Radcliffe Observer.)

The programme of work with the 24-inch photographic refractor on the proper motions of stars in Kapteyn's Selected Areas has been continued. Two series of plates are being taken of each area in the northern hemisphere and of those on the equator, 135 areas in all, including the special fields. The first series consists of plates containing two exposures of thirty minutes at each epoch, the time interval being at least ten years. The second series consists of pairs of plates each containing two exposures, the plates at the second epoch being taken with the glass side turned towards the objective. At present nearly half of

the plates of the second epoch have been obtained, but only four areas have been completely reduced.

During the year the following plates were taken:

36 plates on Selected Areas for P.M.
5 ,, Radcliffe parallax fields for P.M.
3 ,, Præsepe for P.M.
12 focus and test plates.

The weather, especially during the latter half of the year, was most unfavourable for long-exposure work.

Of the plates of the Selected Areas 19 only have been passed for measurement, several of the remainder and most of the test-plates being rejected in consequence of the failure of the plate emulsion to come up to the usual standard of speed. The plates of the parallax fields and of Præsepe, taken at the request of Professor van Rhijn for comparison with earlier plates of the same areas, have been sent to him for measurement. He now has 100 Radcliffe plates for this purpose.

Eleven plates were measured and partly reduced during the year. This represents six areas with a total of 916 stars, or an average of about 150 stars for an area. The limiting photographic magnitude reached is about fifteen, varying from 14·7 to 15·4 on the plates as yet measured. The probable error of a P.M. in one co-ordinate (mean of two plates) determined from the discrepancies of the two series of plates is of the order of $\pm 0''{\cdot}005$. Some modifications of the original plan of reduction have been introduced with a view to accelerating the work.

The reduction of the test-plate mentioned in the last report indicates that no systematic errors depending on magnitude are introduced by different rates of clock-driving of the telescope. Observations of the adjustments of the telescope showed them to have remained constant.

The occultation of Aldebaran on April 8 was observed by three of the staff.

Until September the transit-circle was used occasionally for the determination of clock error. In that month it was necessary to cover it up owing to repairs to the building, and a W/T receiving apparatus was installed. The latter will in future be used for determining clock error.

Radcliffe Observations, vol. liv., part 3 (Meteorological), was printed and distributed as usual. The present Radcliffe Observer took up duty on August 18. Until that date Mr. W. H. Robinson, First Assistant, was in charge, Dr. Dreyer continuing kindly to act in an advisory capacity. There has been no other change in the staff.

University Observatory, Oxford.
(*Director, Professor H. H. Turner, F.R.S.*)

Volume vii. (zone $+58°$) of the Vatican Astrographic Catalogue is fully printed, and one or two copies have been issued; but there has been delay about the general distribution. Volume viii. (zone $+57°$)

is printed to $6^h\ 54^m$ (33,000 stars, about half the volume). The entries in the ledgers are now complete for zones $+64°$ to $+56°$; those for $55°$ refer to an overlapping catalogue and are thus treated separately. The examination of the ledgers for discordances showed that the work of one particular measurer, only employed for a short time, was not up to the standard, and it was decided to remeasure all her plates. The dozen in zone $+57°$ were required at once as that zone is being printed, and these are now fully measured (at Rome) and reduced (in Oxford). Six others in zone $+58°$ have been remeasured and reduced, and the new measures will be given in an Appendix; only two remain to be done.

The alteration of the tube of the 12·2-inch visual lens (used as a guiding telescope in taking astrographic plates) is now completed, and the telescope is in working order. But no definite programme of work has yet been undertaken. It will probably deal with the repetition of plates in some way or other; but the choice of a precise plan is not yet made.

Dr. Fotheringham has continued his valuable researches in ancient astronomy and chronology. Early in the year he investigated the Metonic and Calippic Cycles (*M.N.*, **84**, 383–392); but his attention has recently been absorbed by the prospect of obtaining a definitive Babylonian chronology, especially by use of the recorded observations of Venus. Using a secular acceleration corresponding to those for the Sun and Moon inferred from his own work on eclipses and occultations, he arrived at a unique astronomical solution. There is, however, much evidence available of other kinds, as, for instance, the contracts for the division of dates between landlord and tenant, with the implications as to the month when they were ripe; and it is clearly desirable to examine all this evidence to see whether it supports the conclusions derived from the Venus observations. This has involved very considerable labour, both in computation and in research, in which he has been ably assisted by Herr Schoch, with whom he was already in correspondence. The results of his investigations will shortly be given in a volume which he is preparing. Some of them have already been announced in an abstract printed by Herr Schoch.

The seismological reductions are complete to the end of 1921 April, and are printed to the end of 1920 September. In the last report the printing was up to 1919 March, so that six months' arrears have been caught up during the year. This is due to the help received from Dr. J. E. Crombie and the Board of Scientific and Industrial Research, who have between them provided the salary of Mr. J. S. Hughes. The form of the International Seismological Summary (into which the former Shide circulars have now developed) was approved by the Section of Seismology at the Madrid meeting of the International Geodetic and Geophysical Union in October; and increased funds were voted for its maintenance. The cases where the relative focal depth of a shock was abnormal and could be estimated from the arrival of waves at the antipodes of the epicentre continue to accumulate, and Professor Turner was requested at the above meeting of the Union to prepare a summary of this evidence for publication in the official journal.

The MS. of this summary has been accordingly sent to the Central Bureau.

The periodicity of 21 minutes has presented itself in a new guise as a period of about 22 minutes or $\frac{1}{68}$ of a lunar day. The evidence for control by the Moon seems strong, but as the period is no longer quite uniform, the investigation has become very laborious, and it may be some time before a final solution can be given.

During the spring the Observatory lost by death the services of Mr. S. Dolman, formerly a Greenwich computer, and for many years occasionally, recently fully, employed on measuring and computing work here.

The Observatory is suffering some contraction of the open space around it by the erection of buildings for other scientific departments. The contraction is regrettable, but it did not seem desirable to emphasise the claims of the Observatory too strongly in opposition to clear scientific needs in other directions.

Imperial College, South Kensington.
(*Assistant-Professor H. Dingle.*)

A Watson-Conrady 5-inch objective has been purchased for the equatorial recently returned from Russia, and the instrument and its mounting have been thoroughly overhauled and made ready for use. The courses of instruction to students, which for the last eleven years have been carried on under great disadvantages, will now be re-established on their former basis.

Much spectroscopic work has been done during the year; this also has been greatly simplified by the return of the instruments from Russia. The Bakerian Lecture by Professor Fowler on "The Spectra of Silicon at Successive Stages of Ionisation" found an immediate astrophysical application in the theory of ionisation in stellar atmospheres. Preliminary results of the analysis of the phosphorus spectrum have been published by Miss Saltmarsh (*Phil. Mag.*, **47**, 874, 1924), and a number of regularities in the spectrum of singly-ionised nitrogen have been traced by Professor Fowler (*Proc. Roy. Soc.*, A, **107**, 31, 1925). Investigations of several other spectra have been carried on and are still in progress.

Stonyhurst College Observatory.
(*Director, Rev. A. L. Cortie, S.J.*)

Observations of the solar surface were made on 262 days in 1924. The drawings number 257, and of these 224 are complete, and show all spots and faculæ. Of the remaining 33, all except 1 are complete for the spots. The mean daily disc-area of the spots (in units 1/5000 of the visible disc) was 1·36, as compared with 0·37 in 1923, and 1·73 in 1922. Although the new cycle of spots in high latitudes began in 1923 August, the actual minimum in mean daily disc-areas of spots

seems to have occurred at the beginning of 1924. But, except for a few disturbances, the magnets have remained very quiet, illustrating the lag of mean magnetic range on mean sun-spot area.

The Sun's northern hemisphere displayed much greater activity than the southern hemisphere, in the proportion of 60 spot-groups with an area of 73·2 units, to 15 spot-groups with an area of 20·2 units. There were 2 spot-groups with areas greater than 10 units; May 30 to June 11, area 10·1, co-ordinates—latitude +29°·3, longitude 15°·1, and August 29 to September 6, area 11·6, co-ordinates—latitude +21°·1, longitude, 306°·9. The days without spots in 1924 numbered 80, mainly in the months January to April, and in November, as against 122 in 1923, and 93 in 1922. The relative proportions of spotless days to all days of observation in these years were 30·4 per cent. for 1924, 49·6 per cent. for 1923, and 36·3 per cent. for 1922.

The research, on the 27-day period in terrestrial magnetic disturbances, and their relations with definite long-disturbed areas of intermittent sun-spot activity, was completed, and the results were printed (*Proc. R.S.*, A, **106**, 19–32). Also a paper on the red-end spectrum of γ Cassiopeiæ, with table of wave-lengths, was presented to the Society (*M.N.*, **84**, 576–582). A note on the spectroscopic parallaxes of stars is ready for press. Otherwise the abnormal amount of cloud has considerably hampered all spectroscopic work.

The magnetic, meteorological, and seismological observations have been carried on as usual, and the results forwarded to the official centres.

The Rev. H. Macklin temporarily retires as assistant, to pursue his theological studies. His place has been taken by Father B. G. Swindells. Dr. C. Chree visited the Observatory at the end of July, and made a series of observations, in order to compare the Kew and Stonyhurst unifilar magnetometers. The Stonyhurst Dip Circle had been sent to Kew earlier in the year for the same purpose.

University of London, University College Observatory.
(*Director, Professor L. N. G. Filon.*)

Owing to the persistence of bad weather conditions and the change of residence of Mr. Gregory to Hendon, but little night work has been attempted during the past year.

The Observatory clocks have been rated daily by means of the Greenwich time-signal, and a number of transits have been taken. The transit instrument has also been used for research purposes.

The Rowland grating and Littrow spectrographs have been in use throughout the year, and a number of spectrum plates of integrated sunlight have been obtained with the former, but the work was greatly hampered by cloudy weather and the scarcity of actinic light during the comparatively few hours of sunshine which could be utilised with the grating in its present position. The discussion of these plates is still in progress.

The new camera for the Cooke portrait lens has been completed, and works in a satisfactory manner.

Wolsingham Observatory.
(Rev. T. E. Espin.)

The examination of the B.D. stars for new doubles has been continued during the year with the 17¼-inch in the higher zones, and the 24-inch in the lower, and the results, together with micrometrical measures of some known double stars, have been communicated to the Society. The red stars met with in the course of this examination since 1912 have been arranged in R.A., and a general comparison of all the spectroscopic observations with the Draper Catalogue has been made and forwarded to the Society.

Mr. Scriven Bolton's Observatory, Bramley, near Leeds.

The work carried on during the year is practically a continuation of that commenced in 1922, viz., a determination of the periods of new variable stars, and of their type of spectrum. The regions selected are in Taurus, Orion, and Andromeda. A 6-inch Dallmeyer lens of 30 inches focus has been used. The exposures range from half an hour to 4 hours. The plates used are Ilford Iso-Zenith, speed 700 H. and D., size 6½ by 8½ inches.

On only four nights during the whole year did the sky remain free from cloud. However, many exposures were made intermittently. Night watches were kept from sunset to $14^h\ 30^m$. Of the total number of nights, 52 per cent. were sufficiently clear to allow photographs to be taken with exposures ranging from half an hour to 4 hours.

Special attention has been paid to the variability of stars in and around the Pleiades. Owing to the nebulosity enveloping this cluster, any slight change of magnitude of the chief members is not easily detected on the plates, and a more satisfactory way has been to measure the width of each star trail by means of a special Cooke micrometer.

On plates taken since 1922 August of the region around γ Andromedæ (R.A. $1^h\ 15^m$ to $2^h\ 38^m$, N. Dec. 37° to 55°), no fewer than 40 new variable stars have been found. Curves of twenty of the brighter ones indicate periods of from 20 to 70 days. All are of the Cepheid type. Since the observations extend over two and a half years, it is now possible to deduce the periods with a fair degree of accuracy.

The 10½-inch photographic reflector, of 36½ inches focus, is attached to the tube of the 2-foot reflector, and has been designed for rapidity. The field of view, however, is very limited owing to the short focus.

The planets Venus and Mars were observed with the 2-foot reflector during the year. While there was no evidence of axial rotation of Venus, it was pretty evident that the planet's visible surface changed not only from night to night, but from hour to hour. The brightening towards the limb as well as the polar caps, so frequently observed, entirely vanished under good seeing. The surface was seen to be checkered by small white clouds, uniformly distributed over the planet.

Mr. A. A. Buss's Observatory, Chorlton-cum-Hardy.

The year under review afforded only 91 different observational dates, this being partly due to prolonged absence abroad and partly to exceptionally unfavourable weather.

The solar feature distinguishing the past twelve months was a spot-activity almost confined to the northern hemisphere, only very few disturbances of note appearing south of the sun's equator. The same characteristic was exhibited by the prominences. Both spots and prominences, in a very few instances only, showed energetic activity; in fact the period under review shows remarkable gaps, with the sun's disc clear of conspicuous spots and with the prominences scarce and small.

A comparison of the number of prominences seen along the eastern limb with those on the western limb by no means establishes invariability of the reported preponderance of the east over the west in this respect, and a good many and very pronounced instances were recorded in which the western display far exceeded the eastern one.

A number of rather conspicuous facular displays gave the opportunity of seeing D_3 in absorption, a broken-line effect conforming to the pattern of the facular areas being seen. Attention has been drawn to this feature in previous reports from this station, and it seems desirable that better equipped Observatories should follow it up with a view to its confirmation.

Mr. A. M. Newbegin's Observatory, Sutton, Surrey.

The work done during the year 1924 was seriously hindered by the abnormal amount of cloudy weather and the generally bad seeing conditions.

Observations of solar prominences have been continued, but the tabulation for statistical purposes has been curtailed and more attention given to the details of individual prominences, special attention being paid to metallic activity and radial motion.

The sun has definitely entered upon a new cycle of activity, and the dimensions of prominences have much increased. The new grating-prism spectroscope has been in use on a few occasions, but the definition is so far unsatisfactory, and it has been returned to the makers for improvement. Some observations of Mars were made during the autumn months, but on every occasion the definition was extremely poor.

Mr. B. M. Peek's Observatory, Boscombe, Hants.

Photometric observations of Nova Persei 1901 were made on 126 nights. Nova Ophiuchi 1848 and Nova Cygni 1876 have been added to the observing list. Three variables of the U Geminorum type have also been studied photometrically, particularly with reference to their minima.

The $12\frac{1}{4}$-inch reflector has been used for the above observations and for physical observation of the planets, particularly of Mars.

With the 5-inch refractor and Cooke micrometer a programme of measurement of double stars within 35° of the North Pole was continued. This instrument was also used for physical observations of Venus.

In 1924 thirteen occultations of stars by the moon were observed and reduced.

The Rev. T. E. R. Phillips's Observatory, Headley, near Epsom, Surrey.

The year 1924 was an exceedingly unfavourable one for observational work. The general character of the weather is indicated by the fact that the total rainfall reached 40·34 inches, the largest total since the Headley observations were begun in 1916, and precipitation in some form was measured on no less than 207 days. The number of clear nights, too, was small, and occasions of good seeing very rare.

The usual programme of work on the planets was continued. During the earlier part of the year a good deal of attention was given to Venus, on which a few faint shadings were seen, and a white area about the N. limb and cusp which persisted for some weeks. Work on Jupiter was much curtailed in consequence of the low position of the planet in the sky combined with the bad weather. The same causes hindered the observation of Mars at its exceptionally close approach to the earth, but all available opportunities were utilised, and the results obtained have been communicated to the Society.

Photometric observations of certain variable stars in their fainter phases were continued chiefly with the 12¼-inch reflector, and in the earlier part of the year *Nova Persei* (1901) was also observed. Some micrometrical measures of double stars were made with the 8-inch refractor lent by the Society, but various circumstances interfered with the usual work in this department.

Clouds prevented the observation of the *Transit of Mercury* on May 7, and of the *Occultation of Venus* on August 25–26, but the disappearance phase of the *Occultation of Mars* was observed on November 5.

Dr. W. H. Steavenson's Observatory, West Norwood.

The number of fine nights has been considerably below the average, especially during the last four months of the year. However, work of some sort was done on 152 nights.

Photometric work on the novæ has been continued with the 6-inch refractor. As usual, special attention has been given to Nova Persei (1901), which has been observed on 68 nights during the year. The results of work on this and other novæ in 1923 have been communicated to the Society.

Physical observations of Venus in the first and of Mars in the second half of the year were made with the 6-inch.

Comets Finsler and Encke, and the minor planets Juno and Eros, were each observed for position on two or three nights. Photometric observations were also made of Baade's new planet.

Dominion Observatory, Ottawa, Canada.
(Director, R. Meldrum Stewart.)

Meridian Work and Time-Service.—Fundamental observations have been continued on the programme begun in 1923. With observations on 189 days there were obtained 4350 transits and 4295 zenith distances of stars and 93 observations of the sun, besides observations of the moon and planets. Reductions have been partly carried out for all stars; for time and azimuth stars to the point of observed clock corrections. Computations of the previous programme (observations completed in 1923) are being advanced.

The time-service has been maintained as in previous years, without alteration or addition, except that time-signals are now sent out twice weekly at 9 p.m., through the Canadian National Railway broadcasting station at Ottawa.

Wireless time-signals from Annapolis and Lafayette have been received regularly by the method of coincidences by extinction. The rhythmic signals from Nauen are now also being received. A special series of Annapolis signals was received during July and August for reference in longitude determinations in northern British Columbia.

Astrophysics.—The 15-inch refractor has been employed in radial velocity work on bright cepheids, pseudo-cepheids, and stars of the β Canis Majoris type; 1152 spectrograms were secured. It has been found that the radial velocity variations of σ Scorpii involve a combination of three periods—one of about six hours, another of thirty-three days, and a third of a number of years, possibly twelve. It thus appears that this star, apart from the short-period variation, is a triple system. There appear also reasons for considering σ Cygni as a star of very low density accompanied by a companion of the nature of a comparatively small satellite.

The short-focus camera formerly attached to the 15-inch telescope has been transferred to an independent small equatorial mounting, and two similar cameras have been added. All three are of 2 inches aperture and 13 inches focus, and they can be pointed independently. They will be used for the photographic study of variable stars, chiefly cepheids. About 200 plates have already been secured.

A publication, *The Cepheid Problem*, containing a *résumé* of most of the known facts about cepheids and allied types, is now in press.

Solar Physics.—About 400 observations of solar spectra were made; each of these comprises nine spectrum strips of limbs, centre, and midway points of solar disc, with iodine and electric arc spectra for comparison, some of the latter at 250 mm. pressure. The weather was more than usually cloudy and hazy. Some remeasures of early observations for solar rotation were made, and the material is being prepared for publication.

Photographic Photometry.—A certain number of plates have been secured for establishing sequences of comparison stars in the fields of variables, and some work has been done on the development and adjustment of photometric measuring apparatus. A publication, *Photometry with a 6-inch Doublet*, has been completed and is in the press.

Terrestrial Magnetism.—Twenty-three stations were occupied for the detemination of magnetic declination, dip, and horizontal intensity; one party only was engaged in the field. The selected points ranged from latitude 48°·4 to 64°·7 in the vicinity of the Pacific coast and in the Yukon Territory. Progress has been made on computations for the 1922–23 stations.

Gravity.—Observations for the value of gravity were made at some twenty-five stations in Western Canada where topographic maps are available. Considerable progress was also made in the reduction for topography and isostatic compensation of early observations.

Seismology.—The regular work in seismology has been carried on. The same instruments as used in 1923 have been in continuous operation. Improvements in the illuminating systems of the photographic instruments have resulted in a marked increase in the quality of the records. 272 earthquakes were recorded, the records read and monthly bulletins sent regularly to about 230 seismological stations. The location of epicentres has been proceeded with steadily, and a publication for 1921 is expected to be issued shortly; material for 1922 is rapidly nearing completion. A newly developed system of recording and compiling data is expected to allow earlier publication of locations; a report on this is in preparation. A general report on work for 1923 is in the hands of the printers.

The Dominion Astrophysical Observatory, Victoria, B.C.
(*Director, J. S. Plaskett, F.R.S.*)

The Staff.—The staff of the observatory consists of J. S. Plaskett, Director; W. E. Harper, Assistant Director; H. H. Plaskett, Astronomer; J. A. Pearce, Assistant Astronomer; S. N. Hill, Computer; Miss H. R. Keay, Secretary; T. T. Hutchison, Night Assistant. During the summer vacation of five months Mr. W. H. Christie was again employed as Observing Assistant. Dr. Reynold K. Young, Astronomer, resigned on August 1 to accept the position of Associate Professor of Astronomy at Toronto, and he was replaced by Mr. Pearce.

Observing.—The observing weather during the past year has been fully up to the average, as 1468 spectra were obtained on 203 nights. On 126 nights five or more spectra were obtained per night, a total number of 1278; and on 77 nights less than five were obtained per night, with a total number of 190. Of these, fourteen were long-exposure spectra. On 11 nights in addition, although the dome was opened, no usable results were obtained. As usual two hours on each Saturday evening have been given to visitors for observation with the telescope. Otherwise, practically all the observing time has been given to photographing stellar and nebular spectra.

Researches.—The observing time of the Director has been occupied chiefly in obtaining spectra of B-type stars from a programme of all those brighter than 7·5 visual magnitude and north of −10°. In this programme, undertaken in collaboration with Mr. Pearce, it is planned to carry out an investigation for the B's similar to that recently com-

pleted for the O-type stars. Observations were also completed and orbits obtained of a new eclipsing variable, 21 Cassiopeiæ, discovered by Stebbins, and of the double lined B8 spectrum of the brighter component of δ Coronæ Borealis. The research on the O-type stars was completed in the beginning of the year and has appeared as vol. ii., No. 16, of the Observatory publications. The principal facts revealed by this work are the great masses (average about fifty times that of the sun), high luminosities (average −4 magnitude with a probable dispersion of three magnitudes), and the small mean parallaxes of this group (one-thousandth of a second), definitely placing them at the apex of the evolutionary sequence. The emission O's observed were arranged in order of excitation, and it was shown that the broad emission is probably not a function of temperature only, as it appears to develop from any subdivision or temperature of the O stage. An auxiliary result referred to last year was evidence for the existence of widely extended and exceedingly tenuous clouds of matter, showing sharp calcium and sodium lines, throughout space. Investigation of camera lenses for the spectrograph was completed by the construction and testing of a 9-inch focus 3-inch aperture combination for single-prism work giving beautiful definition and a flat field over the photographic spectrum.

Mr. Harper and Dr. Young completed the investigation and preparation for publication of the spectroscopic parallaxes and absolute magnitudes of 1105 stars, which is now printed as vol. iii., No. 1, and will shortly be distributed. This important work is signalised by the use of a number of new pairs of lines for absolute magnitude, by the construction and use of standard scales for estimating line intensities, and by the improvements and care used in developing the curves. As a result it is believed substantial increase of accuracy both as regards systematic and accidental errors has been obtained. In the publication the results of the estimation of the relative intensities of the different pairs of lines is given in detail. This will be useful for theoretical investigations and for comparison with the results of other workers. A number of spectra of A-type stars of known trigonometric parallax have been obtained by Mr. Harper for the extension of the absolute magnitude determinations to this class. He has also completed the orbits of four spectroscopic binaries, three of which are published as Nos. 2, 3, 4 of vol. iii. Dr. Young completed the orbits of two long-period spectroscopic binaries which, with four others nearing completion, will be published later.

Mr. H. H. Plaskett has been occupied the larger part of the year on an investigation of nebular spectra. Observations of a number of planetaries and their nuclei have been obtained, and a complete series of spectra of a new nebular envelope star, Z Andromedæ, discovered by him have been secured. Wedge spectra of the Orion Nebula and N.G.C. 7027 have been obtained for the measurement of the accurate relative intensities of the principal nebular lines. Considerable experimental work was necessary to obtain interferometer observations of the Orion Nebula, and the measurement and reduction of all these plates is practically completed. The results of the investigation will be published early in the coming year. A number of wedge spectra of

high dispersion for determining the actual intensities of the hydrogen absorption lines in Vega, as compared with the adjacent continuous spectrum, have been made, and these will be measured as soon as the nebular work is completed.

Mr. J. A. Pearce has been on the staff only since October 20. He is engaged in collaboration with the Director in the observation and measurement of spectra of the B-type stars, and in addition is at present engaged on the orbits of two B-type binaries.

Mr. W. H. Christie, at the Observatory for five months in the summer, has completed the measurement of the radial velocities of nearly 50 stars, and has also observed and measured over 100 spectra of 12 Lacertæ over several cycles of this interesting short-period object. The measures are now being reduced and discussed, and promise results of interest and value.

Publications.—The *Publications of the Dominion Astrophysical Observatory*, vol. ii., Nos. 15 and 16, completing the volume, and vol. iii., Nos. 1 to 4, have appeared, besides a number of papers in astronomical periodicals by members of the staff.

Helwan Observatory, Ministry of Public Works, Egypt.
(*Director, Mr. P. A. Curry.*)

As was the case last year, the staff was still insufficient to make use of the Reynolds reflector. Four plates only were taken in May in earch of Jupiter's eighth satellite.

The rhythmic W/T signals transmitted from Lyons were observed regularly throughout the year. Transits were taken on 92 nights. The results of the observations of the Lyons signals for the year ending June 30 are now in the press.

A free pendulum clock and slave made by the Synchronome Company were installed during the summer. A good deal of trouble was experienced at first, mainly owing to the difficulty of maintaining a vacuum in the free pendulum case, but this has now been overcome and the rate is keeping very steady, the clock appearing superior to Riefler.

The usual meteorological, magnetic, and seismological observations were made.

Mr. Knox Shaw, who had been Director of the Observatory since 1913, retired in August on his appointment as Radcliffe Observer.

Nizamiah Observatory, Hyderabad.
(*Director, Mr. T. P. Bhaskaran, M.A.*)

The routine work with the astrographic equatorial was continued in 1924 as in former years. Eighty photographs were secured with the instrument, of which about half the number were taken in the usual manner for the Catalogue. Twenty-two plates have been exposed

for the determination of photographic magnitudes of stars in certain regions of zone $-17°$, by comparison with the Harvard standards of magnitudes. Fourteen repetition plates with exposure of 15 minutes have been taken through the glass, so that they can be superposed on the original negatives and measured directly for the determination of proper motions.

The printing of vol. v. (zone $-21°$) of the Hyderabad Astrographic Catalogue has been completed, and copies will be ready for distribution early in 1925. The measures of plates in zone $-22°$ were finished some time ago, and the printing of this volume will shortly be commenced.

The Grubb 15-inch Telescope.—Regular observations of long-period variables were started in 1924 May, but the work was interrupted by the unfavourable weather conditions which prevailed from June to October. Twenty-three stars were under observation and over 110 determinations of visual magnitudes have been made to the end of the year.

Occultations.—Observations of 16 disappearances and 6 reappearances of stars occulted by the Moon were made during the year.

Transit Instrument.—This telescope was in frequent use for obtaining clock corrections.

Seismology.—Daily records have been secured with the Milne-Shaw seismograph, installed in 1923 September. One hundred and thirty-five earthquake shocks were recorded during the year. The results for the period 1924 January to March have been tabulated and forwarded to Oxford.

There have been no changes in the staff of the Observatory.

Kodaikánal Observatory.
(*Director, Dr. T. Royds.*)

The routine work of the Observatory was continued in 1924 on the same lines as in former years. Under the auspices of the International Astronomical Union, the Observatory now collects prominence and H_α spectroheliograms from other observatories for the days on which complete records are not available at Kodaikánal, and the combined results are included in the half-yearly bulletins.

Grating Spectrograph.—A series of comparisons of the solar spectrum with arc spectra has been obtained during the year, and the measurement of these photographs for displacement of the solar lines has been in progress during the year. A vacuum pump has recently been added to the equipment of the Observatory, and comparisons with the arc *in vacuo* will be commenced as soon as opportunity affords.

The research on the tripling of arc lines mentioned in last year's report has been completed. The thallium line 5350 proved to be the most suitable line for furnishing the clue to the tripling phenomenon. This line can assume five distinct phases according to the amount of material in the arc. It was demonstrated that all the lines which undergo tripling, except two difficult cases, were essentially close

doublets, and the several phases which they assume could be completely explained as stages in the process of reversal of the two components of the doublet. There is consequently no ground for believing that the tripling is due to electrical resolution due to atomic fields, and the phenomenon cannot be utilised to estimate atomic fields in the Sun. The results of this research have been sent in for publication but have not yet appeared.

Study of the H_α Line.—The detailed study of the H_α line has been continued throughout the year. Whenever it seemed profitable, spectroheliograms with the slit set on the edge of the H_α line were obtained in addition to the routine spectroheliograms with the slit set centrally for the record of dark markings. Three features are evidenced which appear to be typical of sunspot disturbances: (1) a bright ring round the sunspot, (2) outside this a dark flocculus more or less extensive, and (3) between the dark flocculus and the coarse réseau of the general undisturbed surface of the Sun there is a bright surrounding region consisting of bright patches larger than in the general réseau, interspersed by dark features sometimes suggestive of the spot vortex. The phenomena in the lower levels of the Sun's atmosphere thus revealed are believed to be a necessary accompaniment of spot disturbances.

Union Observatory, Johannesburg.
(*Union Astronomer, Dr. R. T. A. Innes.*)

There have been no changes in the staff. Professor E. Hertzsprung of the Leyden Observatory, who arrived here on 1923 November, has been at the Observatory throughout the year. The Franklin-Adams Star-Camera has been placed at his disposal for photographic investigations of variable stars in the southern hemisphere. The results of his work are being published in the *Bulletins* of the Astronomical Institutes of the Netherlands. Mr. W. S. Finsen has worked at the Observatory as a volunteer assistant from 1924 March, and has been mainly occupied with the reduction of transit of Mercury observations.

26-Inch Refractor.—The mechanical parts of the large telescope were mounted early in the year, with the assistance of the Public Works Department. At the moment of writing, the remaining portions of the telescope including the objective are on their way to South Africa, and it is expected that the telescope will very shortly be in commission. The condition of the object glass has been the occasion of much anxiety, and the question of the final acceptance of the lens from the makers depends upon tests which will be made here.

Yale Observatory Expedition to South Africa.—Dr. F. Schlesinger of the Yale Observatory has decided to erect a 26-inch photographic refractor in South Africa for the determination of parallaxes of southern stars. He is expected to arrive at Johannesburg about the end of 1925 January.

Occultations of Stars.—All occultations of stars by the Moon observed anywhere during the year 1923 have been completely reduced here.

Altogether 338 observations were reduced. A discussion of the results of the observations will appear in a forthcoming circular.

Time-Service.—Throughout 1924 Greenwich Sidereal Time, obtained by means of the rhythmic time-signals sent from Bordeaux, has been used at the Observatory. The sidereal clocks are kept, for convenience of use, $1^h\ 52^m\ 18^s$ in advance of time received from Bordeaux, and the G.S.T. of an observation is obtained by deducting this amount from the clock time and then applying corrections indicated by the Bordeaux signals.

Union Observatory Circulars.—During the year Circulars Nos. 59, 60, and 61 have been issued. With these were included 32 maps of portions of the southern sky. Circular 62 is now in the press.

From June 26 until the end of the year the Union Astronomer was absent on leave in England, the Chief Assistant Mr. H. E. Wood, M.Sc., being in charge.

Hector Observatory, Wellington, New Zealand.
(*Director, Dr. C. E. Adams, Government Astronomer and Seismologist.*)

The Time Service.—The time-signals sent out from the Observatory mean-time clock and the wireless time-signals continue to be distributed. With the single-valve wireless receiving-outfit, time-signals have been heard from Pearl Harbour (NPM), Hawaii, at 11.30 a.m.; from Bordeaux (LY), France, at 7.30 a.m.; and from Annapolis (NSS), Washington, at 8.30 p.m. The regular signals from Annapolis at 2.30 p.m. have never been heard at the Observatory.

An improved wireless receiving-set has been installed at the Observatory, consisting of one high-frequency stage of amplification, one detector-valve, and two stages of low-frequency amplification. With this outfit the time-signals are heard more strongly, and the time-signals from Java (PKX) at 12.30 p.m., and Kavite (NPO), Philippines, have been heard. On an average about 50 per cent. of these signals are heard sufficiently clearly to be made use of.

The time-signal from Nauen (POZ), Germany, at 11.30 p.m., was heard on February 20.

In addition to the ordinary time-signals sent from Pearl Harbour, Hawaii, at 11.30 a.m., the Naval Observatory, Washington, has arranged for the transmission of a scientific time-signal, immediately following the usual one. This has been recorded at the Observatory whenever it was heard, and was similarly recorded by the other observatories round the Pacific.

Longitude.—Special wireless time-signals were sent from the Observatory in 1924 January and February, at the request of the Lands and Survey Department, for a redetermination of the longitude of Chatham Island.

Sun-spots.—Observations of sun-spots are made on every available occasion, and the reports are published in the monthly notices of the New Zealand Astronomical Society.

Seismology.—The earthquake reports for 1923 September, October,

November, and December were printed and distributed to other seismological observatories and to the International Seismological Association.

The valuable service performed by the officers of the Post and Telegraphic Department of reporting earthquakes to the Observatory has been continued. During the calendar year 1923, out of a total of seventy-seven shocks of earthquakes, fifty-eight were felt in the North Island and twenty-seven in the South Island; these include eight which were felt in both islands.

The intensity of the shocks felt in 1923 has decreased somewhat to 6 Rossi-Forel, while the intensities of 1921 and 1922 each reached 8 on the same scale.

Publications.—The following Observatory bulletins have been published during the year: Nos. 51, 52, 53, E. 1, E. 2.

Melbourne Observatory.
(*Director, Dr. J. M. Baldwin, Government Astronomer.*)

Owing to the prolonged illness of the instrument maker, it was not possible to complete the changes that it had been planned to make in the 8-inch transit-circle; these are being proceeded with now, and when they are finished a start will be made with the new observing programme. At the end of the year a new clock of the Edinburgh pattern by the Synchronome Company was ordered, so that the meridian work will be carried on under favourable conditions.

The Fourth Melbourne General Catalogue of 5157 stars, used as reference stars in the *Astrographic Catalogue*, has been completed and is in the printer's hands. It includes two appendices, giving full data for proper motion of the stars in this catalogue, and also of the stars in the same region contained in the Third Melbourne Catalogue.

The Fifth Melbourne Catalogue of 2450 stars south of $-64°$ has been completed in card form, and the manuscript will now be prepared for the printer. The calculation of the proper motions is in progress.

The manuscript of the second volume of the *Astrographic Catalogue*, including plates with centres along $-67°$ and $-68°$ has been completed, and arrangements for its publication have been made. The printing will be proceeded with as soon as the first volume is printed. The preparation of the manuscript of the third volume is in hand.

A few of the plates necessary to complete the chart triple-exposure series have been taken, but this work has been much interfered with by exceptionally cloudy and changeable weather.

During the year 2078 observations of southern long-period variable stars have been made, and the results forwarded to Harvard College Observatory and published in *Popular Astronomy*.

The magnetic work at Toolangi has been continued as in 1923. Several alterations to Kew magnetometer 18 were made early in the year so as to give greater accuracy and ease in manipulation. The redesigned instrument has been in regular use since. A sudden change in the vertical force variometer record was found to be due to flaking of one of the supporting points. In consequence, in August

these points were replaced by the original knife edges, after these had been satisfactorily reground. A considerable improvement in sensitiveness was obtained, and has been maintained with but little diminution. Arrangements have been made for measuring the current magnetograms and reducing the results, and this work will be commenced early in the coming year.

Sydney Observatory.
(*Director, Professor W. E. Cooke.*)

Steady progress continues in all branches of our standard work. The following brief description will probably suffice.

Astrographic Telescope.—This instrument is devoted almost entirely to photographing those portions of the sky assigned to the Sydney Observatory by international agreement. A new driving clock for the astrograph was received during the year. Unfortunately, it proved to be seriously defective, and the effort to adapt it has consumed much time and energy. Our output of photographs has, therefore, been less than usual, but there are still plenty in hand to keep the computing staff fully occupied.

The printing of vols. i. and ii. of the *Astrographic Catalogue* was authorised early in the year, but great delay has occurred in the Government Printer's Department. The proofs have been received and revised, and publication may be expected very shortly.

Meanwhile another two volumes are waiting, ready for the printer. Continued efforts will be made next year to expedite the printing of these catalogues.

Transit-Circle.—The new programme of intermediate stars between 30° and 51° S. Dec., commenced in 1923, has been continued, and gratifying progress is reported. We hope to complete it some time this year (1925).

Transit of Mercury.—Good observations of this phenomenon were obtained, and the results sent to the Society.

Wireless time-signals are now transmitted from the Sydney Observatory, *via* the Pennant Hills radio station, at 1 p.m. and 9 p.m. daily.

Research work on international intercommunication continues, and hopes are entertained of submitting a definite plan for consideration by the International Astronomical Union at their next meeting in 1925 July.

Educational.—Both courses, *i.e.* undergraduate and tutorial, have been continued at the University, and the series of articles on elementary astronomy in the school magazine was brought to a conclusion.

An experiment was made near the close of the year in broadcasting a lecturette on popular astronomy. Favourable criticisms have been received and wishes for a continuation expressed. It is possible that this modern method may be developed during 1925.

Notes on some Points connected with the Recent Progress of Astronomy.

Discovery of Minor Planets in 1924.

One hundred and eighteen planets were discovered, or first announced, in 1924, as follows :—

The year is 1923 for the first 6 and PP, 1924 for the others. In several cases planets were discovered in duplicate by different observers ; in such cases only the earlier detection is given.

Letter and Number.	Date.	Magnitude.	Discoverer.	Letter and Number.	Date.	Magnitude.	Discoverer.	Letter and Number.	Date.	Magnitude.	Discoverer.
YO 10	Aug. 16	15·4	GB	QF 1015	Jan. 31	13·2	KR	RJ	Apr. 5	13·3	KR
YO 11	Nov. 11	14·7	GB	QG 1016	31	13·3	KR	RK	28	14·0	JH
YO 12	11	16·0	GB	QH	Feb. 8	15	MW	RL	8	13·7	SB
YO 13 1024	Dec. 2	14·7	GB	QJ	8	15	MW	RM	May 10	13·7	KR
YO 15	Nov. 6	15·4	GB	QK	8	15·5	MW	RN	10	13·9	KR
YO 16	8	15·6	GB	QL 1017	4	13·5	BJ	RO	10	13·5	KR
PK 1011	Jan. 5	13·4	KR	QM 1018	Jan. 31	13·6	KR	RP	Apr. 28	13·0	JS
PL	7	13·9	KR	QN 1019	Feb. 11	13·6	KR	RQ	May 25	13·6	VA
PM 1012	12	13·6	KR	QO	Mar. 3	13·9	KR	RR	June 6	13·0	SB
PN	12	13·8	KR	QP	3	13·6	KR	RS	5	...	ED
PO	12	13·5	MW	QQ	3	13·7	KR	RT 1022	23	12·2	VA
PP	Dec. 24	12·5	BJ	QT	7	13·7	KR	RU 1023	25	13·6	KR
PQ 1013	Jan. 17	12·0	BJ	QU	7	14	KR	RV	July 1	13·6	KR
PR	26	14	KR	QV 1020	7	14	KR	RW	1	13·1	VA
PS	28	13·8	KR	QW	7	13·9	KR	RX	Aug. 6	13·6	KR
PV	29	14	MW	QX	7	14	KR	RY	6	13·4	KR
PW 1014	29	13·6	KR	QY	7	14	KR	RZ	July 29	13·0	VA
PX	30	13·5	KR	QZ	7	13·9	KR	SA	May 30	12	HW
PY	30	13·7	KR	RA	9	16	MW	SB	30	16	HW
PZ	31	14·2	MW	RB	9	14	KR	SC	30	15	HW
QA	31	13·7	KR	RD	1	13·4	VA	SD	June 7	16	HW
QB	31	13·6	KR	RE	3	13·4	VA	SE	Aug. 8	...	ED
QC	31	16·5	MW	RF	11	13·8	KR	SF	26	13·5	JP
QD	31	13·7	KR	RG 1021	11	12·3	MW	SG	June 27	11·5	EH
QE	31	13·4	KR	RH	3	13·0	SB	SH	July 7	13	EH

Letter and Number.	Date.	Magnitude.	Discoverer.	Letter and Number.	Date.	Magnitude.	Discoverer.	Letter and Number.	Date.	Magnitude.	Discoverer.
SJ	July 7	13	EH	SY	Sept. 29	13·9	KR	TO	Nov. 29	13·2	MW
SK	Sept. 5	12·1	SB	SZ	30	15	MW	TP	29	13·3	KR
SL	5	12·9	SB	TA	Oct. 3	13·7	KR	TQ	29	13·5	KR
SM	5	13·7	SB	TB	1	14	VA	TR			
SN	5	13·5	SB	TC	4	13	JK	TS	Dec. 15	14	MW
SO	5	12·8	SB	TD	23	9·2	WB	TT	15	14·5	MW
SP	6	13·5	SB	TE	Nov. 17	13·2	KR	TU	15	14·5	MW
SQ	6	13·2	SB	TF	Oct. 29	13·9	BJ	TV	15	14·5	MW
SR	6	13·2	SB	TG	Nov. 15	13·1	BJ	TW	15	14	MW
SS	7	13·0	VA	TH	22	14·0	JS	TX	22	13·4	KR
ST	3	14·0	BJ	TJ	24	15	MW	TY	22	13·8	KR
SU	22	13·6	KR	TK	24	14	MW	TZ	23	13·6	KR
SV	28	13·7	KR	TL	24	14	MW	UA	26	13·6	MW
SW	29	13·4	KR	TM	25	13·5	KR				
SX	29	14·0	KR	TN	25	13·8	KR				

The initials stand for: VA = V. Albitzky, Simeis; WB = W. Baade, Bergedorf; SB = S. Beljavsky, Simeis; GB = G. van Biesbroeck, Yerkes; ED = E. Delporte, Uccle; JH = J. Hartmann, La Plata; EH = E. Hertzsprung, Johannesburg; BJ = B. Jekhowsky, Algiers; JK = J. Kasansky, Moscow; JP = J. Palisa, Vienna; KR = K. Reinmuth, Königstuhl, Heidelberg; JS = J. Comas Sola, Fabry, Barcelona; MW = M. Wolf, Königstuhl, Heidelberg; HW = H. E. Wood, Johannesburg.

YO stands for Yerkes Observatory.

Planets designated by the following letters were found to be identical with previously known planets: 1923 NK = 576; OC = 279; OZ = 699; 1924 QR = 674; QS = QL; RC = 395; YO. 14 = 142; YO. 17 = 461; YO. 18 = 630. (Later; ST = 467.)

The following planets have received permanent numbers: 1923 NM = 996, NR = 997, NV = 998, NW = 999, NZ = 1000, OA = 1001, (= 1907 BL), OB = 1002, OK = 1003, OS = 1004, OT = 1005, OU = 1006, OX = 1007, PD = 1008, PE = 1009, PF = 1010.

The following identifications are more or less probable: MX with 220, PN with 835, PY with 910, QO with 750, SE with RW, SG with 597, SK with 297. Objects named PT, PU were struck off as defects on the plates.

The following objects were noted as more or less doubtful: QC, QH, QJ, QO, SX, TQ, TT, TW.

The following planets have received names: 795 *Fini*, 797 *Montana*, 824 *Anastasia*, 825 *Tanina*, 852 *Wladilena*, 909 *Ulla*, 910 *Anneliese*,

937 *Bethgea*, 944 *Hidalgo*, 950 *Ahrensa*, 967 *Helionape*, 979 *Ilsewa*, 981 *Martina*, 982 *Franklina*, 986 *Amelia*, 1023 *Thomana*, 1923 NT *Potomac*. Hidalgo is the planet whose orbit extends from Mars to Saturn. It is called after a Mexican hero, in commemoration of the Hamburg eclipse expedition to Mexico, 1923. 1923 NT was thought to be 323 *Brucia*, but this is apparently not so. There are several cases of puzzling similarity between names. Thus 159 *Aemilia*, 284 *Amalia*, 986 *Amelia*: 64 *Angelina*, 965 *Angelica*: 641 *Agnes*, 847 *Agnia*. (Later; 988 is named *Appella*, resembling 198 *Ampella*.)

Mr. Wood conjectured that the object SB might be a Jovian satellite, as it remained near Jupiter from May 30 to June 7. The planet TD was of unusual interest from its brightness and its small perihelion distance 1·22; period 4·36 years. It belongs to the same family as Albert and Alinda, but is much brighter than these. Its orbit passes within some $3\frac{1}{2}$ million miles of that of Mars. There was a fairly close approach of the two bodies last autumn. Professor M. Wolf noted that its light varied by $\frac{1}{2}$ mag. on Nov. 29. 132 Aethra was reobserved last summer at the second opposition since its recovery. Mr. C. J. Merfield computes its perturbations by Mars and Jupiter from 1924 to 1926 in *Ast. Nach.*, 5293.

Dr. Witt of Berlin, the discoverer of 433 Eros, has been computing its perturbations up to the date of the close approach to the Earth in Jan. 1931 (nearest approach about Jan. 29, parallax 52″). He announces the conclusion of this work. The German observatories are making arrangements for accurate observation of the stars lying near the planet's track, which will be required as reference stars on the photographs: they invite co-operation in this work at other observatories.

Ast. Nach., 5337, announces a new method of assigning provisional letters to newly discovered planets, adopted after consultation between U.S. Naval Observatory, Washington, and the Recheninstitut, which is adopted from the beginning of 1925.

The double alphabet will begin afresh each year: the discoveries of Jan. 1–15 will be AA, AB, AC . . .; of Jan. 16–31 BA, BB, BC; of Feb. 1–15 CA, CB, CC . . . and so on. The letters will be assigned in the order in which news of discovery reaches the Recheninstitut or the *Ast. Nach.* There will seldom or never be more than 25 discoveries in a half-month; if there should be more, after AZ the designations will be AA_1, AB_1, etc. The year must always be prefixed to the letters, but I suggest that the last two digits of the year will amply suffice, and will save a good deal of space. The great advantage of the new system is that it will admit the insertion of belated discoveries in approximately their proper place, instead of using the various supplementary systems that are now employed. The system of the double letters AA, AB . . . began in 1893. The double alphabet from AA to ZZ has been completed nearly 3 times, making a total of 1726 designations. A. C. D. C.

Report on Comets in 1924.

The comets 1922 *c* (Baade) and 1923 II. (D'Arrest) were still under observation at the beginning of 1924. Both were photographed by Dr. Baade at Bergedorf on Jan. 28.

Comet 1924 *a* = 1924 I. was discovered at Capetown by Mr. William Reid on Mar. 30. It was fairly bright, and visible in a small telescope. It had a distinct nucleus and traces of a short tail. Its position south of the Sun rendered it invisible in Europe for several months, but it was well observed at the Cape till May 21 or longer. Dr. Baade succeeded in photographing it on Sept. 27, and both he and Mr. G. Merton photographed it on Oct. 6, their positions being in full accord. These late observations will be useful for detecting any deviation from a parabola that may be present. The magnitude was only 16 on Oct. 6.

Encke's Comet, 1924 *b* = 1924 III, was first detected by Professor G. van Biesbroeck at Yerkes Observatory on July 31. Mr. G. Merton subsequently detected it on a photograph taken on the same night. It was then of mag. 16, but steadily brightened, becoming a naked-eye object of the fifth magnitude in the morning sky in October. Numerous observations were obtained up till Oct. 20, when it passed too near the Sun for northern observers. It is not known whether any post-perihelion observations were obtained in the southern hemisphere.

There were two predicted orbits, that of the B.A.A. Handbook being based on the 59½-year cycle, which closely reproduces the Jupiter and Saturn perturbations; that of L. Matkiewicz involves Jupiter perturbations only, but the predicted value of T is too early by $0^d{\cdot}007$ only, whereas the other was $0^d{\cdot}064$ too late.

Comet 1924 *c* = 1924 II. was detected with a field-glass by Dr. P. Finsler at Bonn on Sept. 15. It was a naked-eye object, of mag. 4, with a tail 4° in length; it was moving southward pretty rapidly. Perihelion had been passed on Sept. 4 and the comet was receding from both Sun and Earth, so that its brightness soon fell off. It was well observed in Europe and North America up to Oct. 6, and at Johannesburg up to Oct. 19, when it was lost in the Sun's rays. It may possibly be photographed from southern observatories this year, but it will be very faint. The orbit bears some resemblance to that of the comet of 770, which of course is not very exactly known.

Photographs of the comet were obtained by Professor G. van Biesbroeck at Yerkes Observatory in September. Two of these (Sept. 22, 23) are reproduced in *Popular Astronomy* for December. They show a bright coma, 6′ in diameter, and a fan-shaped group of tails. The principal tail, in P.A. 75°, had a sudden bend, which travelled outwards, being 46′ from the nucleus on the 22nd, 52′ on the 23rd; its direction also changed.

Comet 1924 *d* = 1925 I. was photographically detected on Dec. 22 by Professor M. Wolf at the Königstuhl Observatory, Heidelberg. It was of mag. 16. He describes its physical appearance on Jan. 13 thus: "Very faint; but a small fan-shaped nebulosity can be detected whose breadth is ¾′ and height somewhat less; the point of the fan, which is

towards S.S.E., is occupied by a fairly condensed nucleus." Photographic positions were obtained by Wolf on Dec. 22, 23, 25, Jan. 13. On Dec. 26 two photographs were obtained with the 30-inch reflector at Greenwich by Mr. G. Merton. It was also photographed that night at Bergedorf.

A. Kahrstedt of Berlin obtained an elliptic orbit with a period of 11·12 years from the first three observations. The observation of Jan 13 confirms the ellipticity, but shows that the period is shorter, viz., about $7\frac{1}{2}$ years. Kahrstedt's second orbit is nearly identical with that given below, his period being 7·436 years, perihelion Jan. 29·233. The latter element is not very definitely determined, as is always the case when a comet with a large perihelion distance is discovered near perihelion. The aphelion point lies very close to the orbit of Jupiter. There has been no very close approach of the comet to Jupiter in recent revolutions, but there will be a fairly close one at the next aphelion but one. As the comet will be rather badly placed for observation at the next return, and as it is near the limit of photographic detection even when well placed, the prospects of its being recovered at a future apparition are not very bright.

The following are the best orbits available of the comets of 1924 and of 1921 I.; the latter is definitive, and indicates that the comet is an eighth member of the Neptune family.

Comet. Discoverer.	1921 I. Dubiago.	1924 I. Reid.	1924 II. Finsler.	1924 III. Encke.	1925 I. Wolf.
Computer.	Prof. A. Dubiago.	Miss Vinter-Hansen. Mr. J. Johannsen.	Miss Vinter-Hansen. Mr. J. Johannsen.	L. Matkiewicz.	A. C. D. Crommelin.
T in G.M.T. (new style 1925 I.)	May 4·87982	Mar. 13·290	Sept. 4·3455	Oct. 31·429	Jan. 23·9624
ω	97° 26′ 32″	271° 25′ 11″	66° 31′ 35″	184° 43′ 43″	184° 8′ 27″
Ω	65° 59′ 9″	113° 59′ 34″	80° 3′ 23″	334° 37′ 33″	260° 36′ 36″
i	22° 21′ 20″	72° 20′ 22″	120° 9′ 46″	12° 30′ 21″	23° 7′ 9″
ϕ	69° 58′ 55″	...	...	57° 48′ 28″	21° 57′ 47″
$\log q$	0·048102	0·24432	9·60850	9·532748	0·380027
μ	44″·6255	...	...	1074″·092	472″·951
Period (years)	79·50	...	...	3·30344	7·5022
Equinox	1921·0	1924·0	1924·0	1924·0	1924·0

The year of perihelion is that at the head of each column.

The actual value of T for Encke is about $0^{d}\cdot007$ later than Matkiewicz's prediction. A. C. D. C.

Errata in Former Reports.

M.N., 82, 269. Comet 1921 II.; the quantities printed under ω, Ω should be interchanged.

M.N., 83, 289. Comet 1919 IV.; the quantities ω, Ω, i are referred to the equator, not the ecliptic.

Solar Activity in 1924.

Sun-spots.—The sun-spot and facula activity for 1924 shows that the minimum phase has definitely passed and that the new cycle is well begun. The first four months of the year showed very intermittent spot activity and contained 80 per cent. of the total number of spotless days for the year. Since May, however, the Sun has never been quite free from some disturbance or other, and on the 20 days when no spots were visible, faculæ were present to show that the remnants of disturbances were still apparent. With few exceptions, the disturbed zones were between latitudes 20° and 35°. One spot group of exceptional character was of bi-polar type in latitude 5° N., seen successively on the Sun's central meridian on July 11, Aug. 6, Sept. 2, and Sept. 30, with a maximum area of $\frac{1}{2000}$th of the Sun's visible hemisphere. Small short-lived groups in low latitudes are not exceptional at this time of the solar cycle, when they appear as the last traces of the past cycle. An equatorial group of this size and persistency is not only remarkable so near minimum, but its magnetic polarity as observed at Mt. Wilson indicates that it belongs to the new cycle. H. W. N.

The Prominences.—The mean daily areas in square minutes of arc derived from the Kodaikánal photographic records are shown below :—

	North.	South.	Total.
1924 January to June . .	2·71	2·17	4·88
July to December . .	3·23	2·33	5·56

The mean daily numbers were 16·0 and 15·1 respectively in the two half-years.

Compared with the year 1923 the above figures indicate an increase of 19 per cent. in areas, the increase being more marked in the northern hemisphere.

The distribution in latitude was much the same as in the year 1923, with maxima at about 50° in both the hemispheres, but a definite increase of activity has been shown in the lower latitudes.

Prominences showing metallic lines were recorded on twelve occasions, all of them during the second half of the year. Of these, ten were in the northern hemisphere. All the metallic prominences were in positions characteristic of the high latitude spots of the new cycle.

329 displacements of the hydrogen lines were observed in the chromosphere and prominences. Of these, 185 were towards the red.

With the increase in sunspot activity, disturbances of the hydrogen and helium lines on the disc have also increased. The number of bright reversals of the H_α line in the neighbourhood of spots was 158, whilst the number of displacements observed on the disc was 51, of which 37 were towards the red. D_3 was observed as a dark line on seventy-four occasions. The activity indicated by these during the second half has been nearly double that during the first half of the year.

Prominences projected on the disc as absorption markings showed

a large increase compared with the previous year. Their distribution in latitude during the second half of the year was markedly different from that of prominences at the limb during the same period, and shows a well-defined secondary maximum at about latitude 30° in both the hemispheres.

There was an excess of prominence areas in the eastern hemisphere and of numbers in the western for the year. In the case of H_α absorption markings, both areas and numbers showed a western excess during the first half-year, and an eastern excess during the second.

A. A. N.

Solar Research in 1924.

Solar Radiation.—A new recording thermo-electric pyrheliometer is described by L. Gorczynski in *Journ. de Phys.*, 1924, 133.

The radiation and temperature of the external photospheric layers are investigated by J. Spijkerboer in *Proc. Amst. Acad.*, 27, 371, where certain assumptions of Lundblad (*Astroph. J.*, 58, 113) are criticised.

L'Astronomie, 1924, 30, contains an article by Lambert, Déjardin, and Chalonge on solar radiation in the far ultra-violet. A review of A. Nodon's experiments on the existence of solar radiation of shorter wave-length than X or γ rays, regarded as a cause of radioactive disintegration, appears in *Nature*, 113, 443. Recent data on solar radiation converted into absolute measures are tabulated by M. Minnaert in *B.A.N.*, 2, 75. Measures of solar radiation at Jungfraujoch are given in *C.R.*, 178, 513, 1924, by E. Stenz. The variability of the solar constant is discussed by E. Stenz in the *Cracow Obs. Bull.* 15, and a criticism of the variations found by Smithsonian observers appears in *A.N.*, 221, 5291, by F. Linke, who attributes the variations to errors of observation, combined with variation of atmospheric transmission from morning to midday, and midday to afternoon during the observations. The variation depending on the variable distance of the Sun is the only one found with certainty. W. E. Bernheime (*Prob. der Ast.*,* 1924, 482) concludes that the results showing variation are not to be considered definite, since the effect of the Earth's atmosphere has not yet been completely removed. It is not possible to prove the reality of short-period variations, but secular changes from year to year are known fairly definitely. Some relations between the solar constant and solar activity are discussed by I. Yamamoto (*M.N.*, 85, 71) on the basis of Mount Wilson spectroheliograms, and Abbot's results are considered fairly confirmed.

Magnetism.—L. A. Bauer (*Terr. Magn.*, 29, 23 and 161) considers cosmic effects in terrestrial magnetism and atmospheric electricity and their physical bearings. Definite cyclic changes, apparently associated with changes in solar activity, are found.

Sun-spots, Faculæ, and Prominences.—Monthly reports of sun-spot observations are published in the *Kyoto Univ. Obs. Bull.* during 1924. Attention is called to a large sun-spot group during the last days of August by F. E. Seagrave in *Pop. Ast.*, 32, 512. From Greenwich is

* *Probleme der Astronomie* (Festschrift für H. v. Seeliger), 1924.

published (*M.N.*, **84**, 740) a paper giving the mean areas and heliographic latitude of sun-spots in 1923, and proper motions in latitude of sun-spots and faculæ (*M.N.*, **85**, 185). The Mount Wilson magnetic observations of sun-spots are published in the *P.A.S.P.*

The change of polarity in the new cycle continues. An article on the "Law of Sun-spot Polarity," by G. E. Hale, appears in the *Proc. Nat. Acad. Sci.*, **10**, 53.

J. Levine in *C.R.*, **178**, 1365, explains double spots of opposite polarity as due to a circulation in a great circle plane through the spots, the prominences being formed in this way also.

A comparison of characteristic features of related pairs of sun-spots in two successive cycles is made by H. F. Newall and Mrs. Beech (*M.N.*, **84**, 528).

D. E. Hadden publishes a review of sun-spot observations at Alta, Iowa, in 1921–1923 (*Pop. Astron.*, **32**, 295). In the *Viert des Ast. Gesell.*, 1924, 159 and 179, there is an analysis of the sun-spot period and its meaning. Annual periodic variation in sun-spots and in the solar temperature are discussed by H. Méméry in *Bull. Soc. Ast., Bordeaux.*

The position of the sun-spot minimum is determined by C. Flammarion in *L'Astronomie*, 1924, 242.

A second paper by C. P. Butler on "The Systematic Distribution of Solar Calcium Flocculi" (*M.N.*, **84**, 134) describes the life-history of bright calcium flocculi. His work on the systematic distribution of bright calcium flocculi is described in *The Observatory*, **47**, 212.

The cause of the great velocity of prominences is discussed by W. Anderson in *Zs. f. Phys.*, **22**, 322.

The Director of the Kodaikánal Observatory issues a summary of prominence observations for the first half of 1923 (*Kod. Bull.* No. 74).

Corona.—B. Fessenkoff (*A.N.*, **220**, 5268) publishes observations of the intensity of the coronal light at the total eclipse of 1914 August 21 in the Crimea, also observations of skylight intensity during the partial phases.

A. D. Ross (*M.N.*, **84**, 660) has an article on the photometric intensity of the corona at the eclipse of 1922 September 21, at Wallal.

W. Anderson (*Zs. f. Phys.*, **28**, 299) discusses the existence of cosmical dust in the solar corona.

Spectroscopic Work.—The technique of solar radiation measurements is discussed by Dorno, Meissner, and Vahle in *Meteorolog. Zs.*, **41**, 234 and 269.

By bolometric measures in the solar spectrum the extinction of radiation in the earth's atmosphere is measured by J. Wilsing (*Potsdam Pub.*, 1924; also *A.N.*, **220**, 5251). An article on "Gravitational Effect in the Solar Spectrum," by C. E. St. John, in *Zs. f. Phys.*, **21**, 159, is in effect a translation of his article in *M.N.* 1923.

The red displacement of the Fraunhofer lines is investigated by W. H. Julius (*Zs. f. Phys.*, **27**, 23).

In the *Arch. Néerlandaises* W. H. Julius and M. Minnaert discuss critically the interpretation of solar spectra (**7**, 245) and the relation between the widening and dispersion in the spectrum from the Sun's limb (**7**, 259). The 3883 Cyanogen band in the solar spectrum is

investigated by R. T. Birge (*Astroph. J.*, **59**, 45); 189 lines suitable for Einstein shift measurement are found and weighted. Recomputation of work by St. John, Grebe, and Bachem using the new weights leads to substantially the same results as before in each case, so their disagreement remains, but many lines of highest weight have not been employed. Tables of the lines, with information about their character, are given.

The Director's report for the Bureau of Standards, Washington, D.C., states that in co-operation with the Allegheny Observatory a complete standardisation of the solar spectrum in international units is being undertaken. The blue and violet regions are measured to 1 part in 5,000,000 already. The programme is planned to cover eleven years to reveal any variation in a sun-spot cycle.

The spectrohelioscope is described by G. E. Hale in *Proc. Nat. Acad. Sci.*, **10**, 361.

Theoretical.—An investigation of pressure and circulation in the reversing layer of the Sun's atmosphere by C. E. St. John and H. D. Babcock appears in the *Astroph. J.*, **60**, 32, and *Proc. Nat. Acad. Sci.*, **10**, 389. New values of solar wave-lengths and unpublished data on pressure displacements furnish a basis for pressure determinations in the reversing layer. Various effects are eliminated by a suitable choice of lines, and a pressure of $0{\cdot}13 \pm {\cdot}06$ atmospheres is found for the lower few hundred km. of the reversing layer. Heights, behaviour near spots, vertical convection, rotation, pressure, and the data from flash spectra are discussed and correlated in a suggested scheme of the Sun's atmosphere.

Pressures at the Sun's surface are investigated by H. N. Russell and by J. Q. Stewart (*Astroph. J.*, **59**, 197). Previous work is reviewed and new methods used. All lines of investigation lead to a pressure of the photospheric gases less than 0·01 atmosphere and an average pressure in the reversing layer not greater than 0·0001 atmosphere. The chromosphere is probably supported by radiation pressure, and the pressure at its base is of order 10^{-7} atmospheres. The width of H_β due to Stark effect may be 100 times that calculated by Hulburt, hence much lower pressures are deduced. Atkinson had calculated the dissociation of TiO_2 vapour in the solar atmosphere, assuming oxygen to be in the molecular state. It is almost certainly atomic, and recalculation results in higher computed pressures in this region.

The production and width of the Fraunhofer lines is discussed by J. Q. Stewart (*Astroph. J.*, **59**, 30). An increase in the number of active molecules in the line of sight is far more effective than thermal Doppler effect in producing widening. A very low density of sodium vapour is found to be needed to produce the D lines in the solar spectrum, but the calculated weight of sodium per sq. cm. column is much greater than selective radiation pressure would support.

The equilibrium of the calcium chromosphere is considered by E. A. Milne (*M.N.*, **85**, 111), who finds that the density law for an atmosphere fully supported by radiation pressure is that of the inverse square, otherwise it is of exponential form. It is shown that the

conditions are such that the calcium chromosphere is fully supported by radiation pressure.

It is to be noted that Stewart in his paper calculates how many atoms are required to produce an absorption line of given intensity, whereas Milne determines the residual intensity just sufficient to support high-level atoms against gravity.

W. H. Julius, in *Proc. Amst. Acad.*, **27**, 451, in discussing the perspective shortening in spectroheliograms and the transparency of the photosphere, points out that the perspective foreshortening towards the limb, which the irregular pattern of flocculi would show if it were due to some bright and dark structure confined to a spherical shell of thickness less than 1000 km., does not occur.

The possible rate of increase of mass of the Sun is discussed by H. Jeffreys in *M.N.*, **84**, 533.

W. Anderson (*Zs. f. Phys.*, **20**, 166) has an article on the dielectric constant of the Sun's photosphere.

A paper by M. Hamy (*C.R.*, **179**, 1012) on the evolution of stars and the diameter of the Sun, deals with the distribution of intensity over the disc.

In *Phys. Rev.*, **38**, 771 there is an abstract of a paper by J. Q. Stewart on the problem of gas opacity.

The pressure in the reversing layer and the origin of continuous radiation from the Sun is investigated by M. N. Saha (*Nature*, **114**, 155), who determines pressure from the limit of series absorption of elements in the Fraunhofer spectrum, since the mean distance apart of atoms is the limiting factor.

Solar Rotation.—A note by H. Kaul (*A.N.*, **220**, 5272) deals with the relation of the motion of the planets to the theory of the rotation of the Sun.

From Greenwich (*M.N.*, **84**, 431) there is an article on the rotation period of the Sun from measures of solar faculæ, and E. W. Maunder and A. S. D. Maunder find the rotation period from magnetic storms (*M.N.*, **84**, 610).

Eclipses and Tests of the Einstein Theory.—Some papers dealing partly with these matters will be found under the heading Spectroscopy.

An article on eclipses and verification of the Einstein theory by P. Salet is in *L'Astronomie*, 1924, 10. In the *Phys. Zs.* there is an article by A. Kopf (**25**, 95) and replies by L. Courvoisier (**25**, 187 and 391) on the Courvoisier effect and the Einstein effect W. H. Julius discusses the use of actinometric results obtainable during solar eclipses (*Arch. Néerlandaises*, **7**, 282). A report of the Sproul Observatory expedition to observe the eclipse of 1923 September 10 appears in *Jour. R.A.S., Can.*, **18**, 95, by J. A. Miller and R. W. Marriott.

M. N. Jewdokemoff has a paper on the total solar eclipse of 1914 August 21 in *Pop. Astron.*, **32**, 513.

A supplementary note on the eclipse of 1922 September 21 appears by W. E. Cooke in *M.N.*, **84**, 193.

Shadow bands are discussed and described by C. S. Hastings (*Pop. Astron.*, **32**, 411), and those at Wallal in *Pop. Astron.*, **32**, 202.

C. A. Chant and R. K. Young (*Pub. Dom. Ast. Obs.*, **2**, No. 15) give

an account of the test of the Einstein deflection by the Canadian expedition to Wallal. The predicted deflections were found.

Miscellaneous.—F. Hayn (*A.N.*, **220**, 5264) records a photographic determination of the shape of the Sun's disc. The equatorial semi-diameter – polar semi-diameter $= -0''{\cdot}035 \pm {\cdot}014$. Combined with the result of Schur and Ambronn (*Mitt. der Kyl. Stern. zu Göttingen*, 1903) this gives $-0''{\cdot}010 \pm {\cdot}006$. There is thus no evidence that the disc is not circular.

The variability of the absorption of the solar atmosphere is investigated by Amerio in *Am. Acad. Lincei*, **33**, 70. R. Sekiguchi (*Mem. Kobe Obs.*, **1**, No. 3) searches for evidence of the existence of a current towards the equator in each hemisphere in the Sun's reversing layer. The speed in latitude 65° is 0·347 km./sec. Observations of the Sun made at Lyons appear in *C.R.*, **179**, 1596 *et seq.*, by M. J. Guillaume. The brightness of Halley's comet is found by S. Orlov (*Pub. Cent. Ast. Obs. Russia*, p. 150) to vary with the sun-spot number.

B. Fessenkoff has articles (*A.N.*, **220**, 5259, and *Pub. Cent. Ast. Obs. Russia*, **2**, 7, 1923) on the constitution of the atmosphere deduced from a photometric analysis of twilight. He uses the observations to determine the rate of decrease of atmospheric density at high levels.

H. L. Alden and P. van de Kamp derive the solar motion from the proper motions of tenth-magnitude stars (*Astron. J.*, **36**, 3). There is a slight increase in R.A. and a marked increase in declination of the apex as compared with values derived from brighter stars. Assuming the increase in R.A. to be due to a systematic error in μ_α, a correction to Boss's value of μ_α is obtained. J. A. C.

Stellar Spectroscopy

including Novæ, Photometry and Spectrophotometry, Spectroscopic Binaries, Spectroscopic Parallaxes, Theory of Spectra and High Temperature Ionisation, Statistical Investigations, o Ceti, and Wave-lengths.

Novæ.—Observations of Novæ in 1923 are recorded by W. H. Steavenson in *M.N.*, **84**, 396.

N. Barabascheff (*A.N.*, **222**, 5327) describes a theory of Novæ involving pulsations and atomic sources of energy.

Balanowsky's Nova in Messier 87 is noted in *H.C.O. Bull.*, 803, as not shown on a plate from Arequipa including 18th magnitude stars in 1904, but found on Harvard and Mount Wilson plates in 1919 and 1920.

H.C.O. Bull., 804, has a note on the magnitude of Nova in N.G.C. 2535, and indicates that 1·4 should be added to Reinmuth's (*A.N.*, 5283) values to reduce them to photographic magnitudes on the present international system.

Nova Cygni III. (1920) has been studied by several workers. In the *Pub. Cent. Ast. Obs. Russia*, **2**, 1923, 161, P. Davidowitsch publishes photographic magnitudes of Nova Cygni III. (1920). The pronounced reddish-orange colour which the Nova reached some time after outbreak was decidedly not of the same nature as in ordinary stars, for

the colour-index did not increase. This suggests simultaneous increase in both ends of the spectrum, *e.g.* emission bands. The C.I. was positive during the rapid fall, became zero in the period of fluctuation, and later became negative. These changes agree with direct estimates of changes of spectral class. On p. 184 an apparent nebulosity is explained as an extra focal image. Visual magnitude observations of this star from 1920 August to 1921 January are recorded in *A.N.*, **220**, 5275, by N. Wladimissky, and photographic observations from 1920 August 24 to 1921 September 17 are given by P. Davidowitsch in *A.N.*, **221**, 5296. He discusses these in relation to other observations. The C.I. is discussed. He concludes that the star's effective temperature reached a minimum at the light maximum and that it shows no decrease with decreasing brilliancy.

Nova Persei (1901) has been observed by B. M. Peek, who records photometric observations (*M.N.*, **84**, 541), and W. H. Steavenson (*M.N.*, **84**, 538) during 1923–1924.

H.C.O. Bull., 808, shows that the asteroid Pallas occupied the position of the suspected Nova Herculis 47 (1909) on a Harvard plate.

Nova Aquilæ III. (1918).—A study of the nebulous aureoles and the behaviour of photographic images of Novæ is made by P. Davidowitsch in a paper on the photographic image of N. Aquilæ III. and of other Novæ (*The Observatory*, **47**, 150).

Observations of the brightness of Nova Aquilæ III. (1923) are recorded by C. L. Janssen in *A.N.*, **222**, 5306.

Photometry and Spectrophotometry.—The distribution of energy in several stellar spectra (F5, A, B) is given by J. Baillaud (*C.R.*, **178**, 1604). Procyon (F5 dwarf) is the only one that approximates throughout its spectrum to black body form. He supposes that the origin of the continuous spectrum is not the same for white as for yellow stars.

Radiometer measurements of stellar energy spectra are recorded by C. G. Abbot (*Astroph. J.*, **60**, 87). Using a new type Nichol's radiometer and the 100-inch telescope at Mount Wilson, the spectra of nine bright stars are investigated. The results are reduced to a normal scale by comparison with the Sun and amplified by the work of other observers. Black body curves are fitted and temperatures and diameters deduced. The diameters are of the same order as the interferometer values and Russell's theoretical estimates.

A preliminary report on the brightness of absorption lines (*H.C.O. Bull.*, 805) shows that in B and A stars the residual intensity in $H_{\beta, \gamma, \delta, \epsilon}$ is much higher than is generally supposed. Vega, Altair and Sirius are cited as examples. If all radiation from Vega were cut off except that from the absorption line H_δ it would be of fourth photographic magnitude and of absolute luminosity more than twice as bright as the Sun.

In the same bulletin (805) a broad absorption band in class A spectra is described extending in Vega through one-third of the distance between H_γ and H_δ, the maximum at λ4160 showing 3·5 per cent. loss of light. The loss is probably due to the cyanogen band at λ4215.

The influence of focussing on photographic effective wave-lengths is discussed by O. Bergstrand (*A.N.*, **220**, 5280). For a 20-cm. objective of 995-mm. focus, he finds that for a few tenths of a mm. there is no noticeable influence. The dependence of the effective wave-length on the intensity of the spectrogram is slight for the earlier spectral classes but appreciable for the later ones, increasing with strength of exposure.

The dependence of the photographic effective wave-length on the chromatic correction of the objective is discussed by O. Bergstrand in *Prob. der Ast.*, p. 286,* where also (p. 115) G. Eberhard has a paper on the determination of effective wave-length.

Experimental work on the connection between effective wave-length and absolute temperature is described by M. Mäder in *A.N.*, **223**, 5338.

Measures of line intensities are given by A. Kohlschutter (*A.N.*, **220**, 5276). Absolute values are found and preliminary results given. As an example, for Ao type stars the intensity ratio (centre of H_δ to adjacent continuous spectrum) was found to have values ranging from half a magnitude to one magnitude. For the K line (Ca^+) the ratio varied from one-fifth to two-fifths. For the K line and the hydrogen lines in the later types, the intensity-differences were found to be more pronounced.

Visual observations of 80 bright stars with a new micrometer and grating are given by H. J. Gramatzki in *A.N.*, **222**, 5314.

J. Hopmann (*A.N.*, **221**, 5213) gives colorimetric observations of stars made at Bonn and tabulates temperatures.

Photometric observations on R Leonis, RX Virginis, and R Virginis are given in *Acad. Lincei*, **33**, 17 (Aurino).

E. Zinner (*Prob. der Ast.*, p. 338) has an article on "The Determination of Magnitudes and the Colour Equation," and on p. 247 P. J. van Rhijn concludes, in a paper on "The Distribution of Absolute Magnitudes," that we are not justified in assuming the non-existence of M stars intermediate between giants and dwarfs merely because we have not yet found them. They are only to be expected in appreciable numbers amongst stars of the ninth apparent magnitude and fainter.

H. H. Turner publishes an article on "The Stellar Magnitudes of the Astrographic Catalogue" (*M.N.*, **84**, 735).

Other papers on special stars or groups of stars are those of F. H. Seares (*P.A.S.P.*, **36**, 142) on "The Brightness of Wolf 358"; A. Kienle and P. Bruggencate (*Zs. f. Phys*, **28**, 373) on "Absolute Brightness of the Pleiades"; and in a paper by K. Graff (*A.N.*, **221**, 5282, and **221**, 5290) on "Visual and Photographic Scales of the Faint Pleiades Stars" corrections of visual to photographic magnitudes are given. Determinations of photographic brightness and colours in the Hyades region are recorded by K. Graff (*A.N.*, **220**, 5265).

G. Prasad (*M.N.*, **84**, 493) discusses the mean absolute magnitude derivations in Young and Harper's paper referred to under Spectroscopic Parallaxes below.

* *Probleme der Astronomie* (Festschrift für H. v. Seeliger), 1924.

H.C.O. Bull., 797, contains a favourable check on the Mount Wilson system of magnitudes in Messier 13 by an independent determination of a photographic sequence in and near the cluster by Miss Leavitt.

The temperatures and apparent semi-diameters of 134 stars are given by A. Brill (*A.N.*, **223**, 5335); he gives a reduction of the scale of Rosenberg and of Wilsing, and of the scales of colour-indices of King, Bottlinger, and Hertzsprung, and normal scales of c/T values for the spectral types. P. Guthnick (*Prob. der Ast.*, p. 391) summarises the results of twelve years' work of photo-electric photometry at the Berlin Observatory.

A note on the application of three element vacuum tubes to stellar photometry appears in *P.A.S.P.*, **36**, 64, by H. Benioff. *L.O.B.* 349 contains a description of the photo-electric photometer of the Lick Observatory, and some results obtained with it by Edith E. Cummings.

J. Schilt (*B.A.N.*, 60) gives a description of the new thermopile microphotometer of the Leiden Observatory. A paper by T. R. Merton (*Proc. Roy. Soc.*, **106**, 378) describes an ultra-violet spectrophotometer, using a thin wedge of sputtered platinum on quartz working to $\lambda 2537$.

Improved radiometer construction is described by A. Tear in the *Phys. Rev.*, **23**, 305 (A 60) and 641.

The application of the amplification of current in photo-electric cells to astronomy of precision is discussed by M. R. Jouaust in *C.R.*, **179**, 754.

C. F. Meyer and D. W. Bronk (*Astroph. J.*, **59**, 252) discuss the effect of interference on the intensity of infra-red radiation transmitted through mica, and describe a cell for infra-red spectroscopy which eliminates interference effects and embodies other novel features.

W. S. Franks records (*M.N.*, **85**, 86) the observed colours of 205 red stars.

F. Allison (*Astroph. J.*, **59**, 210) gives a mathematical theory of interference fringes from a single source, and shows how it can be used to find effective wave-length for any double star of known black body temperature. Good agreement is found with Anderson's experimental value for sunlight.

An abstract of a paper by E. A. Kreiken on the colours of faint stars in the Milky Way and the distance of the Scutum group is quoted in the *Observatory*, **47**, 130.

Spectroscopic Binaries.—*L.O.B.* 355 contains the third catalogue of spectroscopic binaries by J. H. Moore.

The nature of spectroscopic binaries of short period is discussed by O. Struve (*Astroph. J.*, **60**, 167). The relation between the period P and the semi-amplitude of velocity variation K is in agreement with the double-star hypothesis for periods longer than 2·4 days. For Cepheid variables there is no change in K corresponding to a change in P. Spectroscopic binaries of period less than 2·4 days consist of two distinct groups, one of small K and one of large K. The average total mass and spectral type for the 144 stars investigated is given.

R. A. Rossiter (*Astroph. J.*, **60**, 15) detects an effect of rotation during eclipse in the velocity of the brighter component of β Lyræ and

notes the constancy of velocity of this system. Some results of a spectrographic study of the Algol system are published by D. B. McLaughlin (*Astroph. J.*, **60**, 22), and orbital motion is suggested as a possible cause of negative parallaxes of certain stars.

The orbits of two dwarf spectroscopic binaries (HD 27130 and HD 96511) are given by R. F. Sanford (*Astroph. J.*, **59**, 356); J. A. Pearce gives the orbit of δ Trianguli (*L.O.B.*, 352); J. S. Plaskett gives the spectroscopic orbit of 56°2617, class O6, temperature 21,000° (*Pub. Dom. Astroph. Obs.*, 1924); O. Struve publishes the orbit of 43 θ^2 Orionis (*Astroph. J.*, **60**, 159).

Spectroscopic Parallaxes.—The absolute magnitudes and parallaxes of 1080 stars are investigated by R. K. Young and W. E. Harper, and the main conclusions, with details for stars of type K and M, are published in *Journ. R.A.S., Can.*, **18**, 9. The results for the K-type giants are in disagreement with the Mount Wilson values. Stars with the *c*-characteristic form a part of the stellar sequence, their spectra differing only in degree from those of other stars. *L.O.B.*, 345, contains an article by W. J. Luyten on the parallaxes of stars determined from spectral class and proper motion. D. L. Edwards gives spectroscopic parallaxes of 100 B-type stars in *M.N.*, **84**, 366, and W. S Adams and A. H. Joy publish the spectroscopic parallax of ε Indi (Type K 5, abs. mag. +7·2, spec. parallax 0″·31) in *P.A.S.P.*, **36**, 142. An investigation of the absolute magnitudes of class A stars by means of the trigonometric parallaxes available appears in *H.C.O. Bull.*, 797.

An article on the distances of the B stars appears by D. L. Edwards in *The Observatory*, **47**, 19.

The reality of spectroscopic parallaxes is discussed by P. Doig (*Observatory*, **47**, 119).

Theory of Spectra and High Temperature Ionisation.—The breadth of the hydrogen lines in stellar spectra is investigated by E. O. Hulburt (*Astroph. J.*, **59**, 177). In contradiction to other evidence, a pressure of several atmospheres is required to obtain the observed widths on the basis of the Stark theory of broadening and the Saha theory of temperature ionisation, but the assumption of a considerable number of free electrons in the atmosphere might explain the discrepancy.

A second paper on the maxima of absorption lines in stellar spectra, by R. H. Fowler and E. A. Milne, appears in *M.N.*, **84**, 499. R. H. Fowler also discusses (*Phil. Mag.*, **47**, 257) statistical equilibrium and ionisation by electron impacts, and there is a paper by E. A. Milne (*Phil. Mag.*, **47**, 209) on statistical equilibrium in relation to the photo-electric effect and its application to the determination of absorption coefficients.

A study of line intensities in stellar spectra is made by D. H. Mentzel (*H.C.O. Circ.*, 258). The spectra of 20 typical giant stars B8 to M3 are examined and the intensities of important lines tabulated. Quantitative agreement with Fowler and Milne is excellent and some ionisation potentials are estimated. Further examination indicates that a revision of the theory is necessary. General considerations, and estimates of temperature and pressure in certain classes and for some particular stars, are given.

An article on the temperature of stars is published in *L'Astronomie*, 1924, 57.

An astrophysical determination of the average life of an excited calcium atom is made by E. A. Milne (*M.N.*, **84**, 354). The result is of the same order as spectroscopic theory leads us to expect. A theoretical deduction of the average duration of upper quantum states, from the distribution of intensity in an absorption line, is made by R. C. Tolman (*Phys. Rev.*, **23**, 693). The Einstein formula is used and an expression for $1/\tau$ found. The available observations are used to calculate values of τ (the average duration) for several quantum states in various elements and compound gases.

F. M. Kannenstine (*Astroph. J.*, **59**, 133) finds evidence in favour of a long-lived metastable helium atom, and A. J. Dempster (*Astroph. J.*, **59**, 142) supports this in a theoretical discussion of the experiments.

Ionisation in the atmospheres of the hotter stars is investigated by Miss C. H. Payne (*H.C.O. Circ.*, 256). Temperatures for the reversing layer of giants from Ao to O*d* are derived and astrophysical estimates of the ionisation potentials of several atoms are made. The latter are in general agreement with laboratory results.

In *H.C.O. Circ.*, 252, Miss Payne investigates the absorption lines of Silicon in stellar atmospheres. The work indicates higher temperatures than have usually been assumed for the hotter stars. A note on the spectra and temperatures of the B stars appears by Miss Payne in *Nature*, **113**, 783, and a synopsis of the ionisation potentials of the elements in *Proc. Nat. Acad. Sci.*, **10**, 323.

Cumulative ionisation in stellar atmospheres is the subject of a paper by M. C. Johnson (*M.N.*, **84**, 516).

The relative temperatures required to produce the oxide bands of zirconium and titanium are found by A. S. King (*P.A.S.P.*, **36**, 140), whose furnace experiments show the zirconium bands belong to the oxide and require higher temperatures for their production than do those of titanium oxide. The high current arc as a spectroscopic source is described by A. S. King in *P.A.S.P.*, **36**, 353. The high temperature lines are strengthened, Classes I. and II. being weak compared with Classes III., IV., and V.; widening is much exaggerated and oxide bands are eliminated.

N. A. Catalan publishes (*Nature*, **113**, 889) the relation between pressure shift, temperature class, and spectral terms for the iron lines (continued in *Nature*, **114**, 192).

An article on the broadening of spectral lines appears in the *Phys. Zeit.*, **25**, 73, by J. Holtsmark. The following subjects are also discussed:—the ionisation of potassium vapour by light, by R. Samuel (*Zs. f. Phys.*, **29**, 209); critical potentials and spectra of arsenic, antimony and bismuth, by A. E. Ruark and others in the *Phys. Rev.*, **23**, 770; the ionisation, excitation, and dissociation of gases, by A. Ll. Hughes (*Phil. Mag.*, **48**, 56); ionisation potentials for helium and fifteen compound inorganic gases, by C. A. Mackay (*Phys. Rev.*, **24**, 319), and the absorption by non-luminous magnesium vapour, by A. L. Narayan, D. Gunnaya, and K. R. Rao (*Astroph. J.*, **60**, 204); $\lambda 4571$ appears as a very sharp line at high temperatures, $\lambda 2852$

appears at low temperatures and widens very much at higher temperatures.

In *Nature*, **114**, 859, S. Rosseland makes a suggestion as to the origin of the nebulium lines. Just as the 2_1 orbit of the hydrogen atom is metastable, so a helium atom may be expected to have possible configurations in which the non-series electron occupies an orbit of slight metastability. The author suggests that transitions from these configurations would give rise to new lines, and attributes the nebulium lines to such transitions.

The spectrum of nebulium is discussed in an abstract by H. B. Lemon in *Nature*, **113**, 764, and in the *Phys. Rev.*, **23**, 766, A 22 ; and in *Phys. Rev.*, **23**, 767, A 23, an apparently new spectrum associated with a spectrum of unknown origin in tails of certain comets (Daniell and Moorhouse) is described.

Different types of ions in hydrogen are described by H. D. Smyth in *Nature*, **114**, 124. The same writer investigates the ionisation of oxygen and hydrogen in *Proc. Roy. Soc.*, A, **105**, 116.

K. T. Compton and H. N. Russell (*Nature*, **114**, 86) advance a possible explanation of the behaviour of the hydrogen lines in giant stars. The effective weight of the two-quantum state is supposed very largely increased in such a way that it becomes greater as the pressure is diminished.

The O-type Stars.—The Publications of the Dominion Astrophysical Observatory, Victoria, **2**, 287, contains a complete discussion of the O-type stars by J. S. Plaskett. The memoir begins with a summary of existing knowledge, and a description of H. H. Plaskett's new method of classification. The individual velocities from 528 spectra of 80 stars observed are given, followed by a statistical discussion containing a chart and description of the distribution of the O-stars with the mean parallax of 35 O and 10 B-stars ; absolute magnitudes are derived for the stars of O type, and space velocities are derived by Strömberg's method The H and K calcium lines are investigated, the hypothesis of stationary surrounding clouds is shown to be inadequate, and a hypothesis is developed of the existence of widely extended very tenuous clouds of calcium and sodium in which the star moves. Wolf-Rayet stars are defined as those with broad emission bands, those with narrow emission lines are classed with the absorption O's. Analogy of constitution and state between the O and W.-R.-stars is found from probable identification of the bands. The W.-R.-stars are arranged in order of excitation, and an hypothesis is advanced about the relations between the absorption O's, W.-R.-stars and the planetary nebulæ.

J. S. Plaskett also discusses the problem of the O-type stars in *Prob. der Ast.*, p. 328.*

The stationary calcium lines in O- and B-type stars are discussed by H. Kienle (*M.N.*, **84**, 583).

An investigation of the spectra of class O stars is made by Miss C. H. Payne (*H.C.O. Circ.*, 263). The material does not warrant the conclusion that variations of emission intensity occur for any star examined. Except for some O*b* stars, it is believed that all Wolf-Rayet

* *Probleme der Astronomie* (Festschrift für H. v. Seeliger), 1924.

stars have absorption lines as well as emission spectra; incipient emission lines have been found in some Oe5 stars. The spectra are arranged in a temperature sequence at any point of which W.-R. emission may appear, but it is more frequent at the higher temperatures. Line identification in γ Velorum is discussed. Bases of classification are investigated, and the arrangement in a physical sequence is deemed the most that can usefully be done.

R. E. Wilson (*Astron. Journ.*, **36**, 1 and 2) discusses the motion, mean distance, and luminosities of the class O stars.

Classification.—The publication of the *Henry Draper Catalogue* of stellar spectra has now been completed.

B. Lindblad (*Astroph. J.*, **59**, 305) compares the Harvard and Mount Wilson classifications of A-type stars. The difference between the reduction curves for deriving absolute magnitude, used by Adams and Joy for A-type stars with sharp and nebulous lines, seems to be due entirely to a systematic difference in the Mount Wilson types for these spectra. Improvements in the method of classifying short and narrow objective prism spectra of early type are suggested.

The following are references to papers relating to red stars:—P. W. Merrill (*P.A.S.P.*, **36**, 97) on red stars; three red dwarfs of class Ma (*H.C.O. Bull.*, 794); a very red star in M37 with C.I. $>4\cdot1$ by H. v. Zeipel (*A.N.*, **221**, 5288); note on red dwarf C.P.D. -49° 11439 (*H.C.O. Bull.*, 801); new red stars by T. E. Espin (*M.N.*, **85**, 93), and the red stars in the *Draper Catalogue*, T. E. Espin (*M.N.*, **85**, 98). F. H. Seares (*Nature*, **114**, 313), in a note on v. Zeipel's red star near M37, gives the probable colour-index as 5·0.

R. H. Tucker notes a faint proper motion star Cordoba General Cat., 25975 (*P.A.S.P.*, **36**, 295).

In *H.C.O. Bull.*, 796, a peculiar class A star C.D. -26° 16876 is described, it is either of low luminosity or of excessive speed. It is also noted by R. Trumpler (*P.A.S.P.*, **36**, 343). A note on B.D. $+51^\circ$ 658 appears in *H.C.O. Bull.*, 798.

Ten new variable stars near globular clusters are noted in *Pop. Ast.*, **32**, 323, and a dwarf of small proper motion (16*c* Ursa Maj.) in *Pop. Ast.*, **32**, 324, and also in *H.C.O. Bull.*, 802; it is a spectroscopic binary of low luminosity, with very small proper motion.

W. J. S. Lockyer presents (*M.N.*, **84**, 409) some recent observations of bright hydrogen line stars.

A paper on effective wave-length and spectral classification of faint stars appears in *M.N.*, **84**, 425, by C. R. Davidson and E. Martin.

W. S. Adams and A. H. Joy publish a note (*P.A.S.P.*, **36**, 141) on the spectrum of Cordoba Zone 5^h 243, and rate it as M1. In *P.A.S.P.*, **36**, 142, the same writers describe narrow bright lines in the centre of the H and K lines in 61^1 Cygni.

Notes on stars of spectral classes R, N, and S, and a note on the spectrum of N.G.C. 6992 are found by R. F. Sanford in *P.A.S.P.*, **36**, 349 and 351 respectively.

The spectrum of S Carinæ is noted is *H.C.O. Bull.*, 798.

Absorption bands in celestial spectra are discussed by F. E. Baxandall in *M.N.*, **84**, 568.

Peculiar spectra in the Large Magellanic Cloud are described in *H.C.O. Bull.*, 801, eight more O*a*, O*b*, O*c* spectra are given, and a list of P Cygni class stars in the cloud.

Baxendell's observations of β Lyræ are discussed by Miss M. A. Blagg (*M.N.*, **84**, 629).

B. Gerasimovic investigates (*A.N.*, 5290) the dependence of K effect on absolute magnitude. He finds a positive K term in F dwarfs and K giants.

The spectrum of γ Cassiopeiæ from H_β to B is given by Stonyhurst College Observatory in *M.N.*, **84**, 576.

Radial Velocities.—The radial velocities of stars of spectral class R are investigated by R. F. Sanford (*Astroph. J.*, **59**, 339). Twenty-nine stars of class R, one of class S, and a variable star are tabulated. The solar motion derived is in agreement with that from stars in general. Parallactic and peculiar motions give mean absolute magnitude $-1\cdot5$; they are nearly like Moore's N stars in luminosity.

W. S. Adams, A. H. Joy, and R. F. Sanford (*P.A.S.P.*, **36**, 137) list 97 stars with variable velocity in two tables—I., a new list of spectroscopic binaries; II., a new list of variable stars of several types.

Real and apparent radial velocities are discussed by Miss A. V. Douglas in *M.N.*, **84**, 491.

A. W. H. Christie lists the radial velocity of fourteen stars in *Jour. R.A.S. Can.*, **23**, 165, and J. H. Moore (*P.A.S.P.*, **36**, 145) notes 7 stars of variable radial velocity.

The radial velocity of ϵ Aurigæ is noted by Ludendorf in *Sitz. der Pruss. Akad. Berlin*, **8**, pt. 9, 49.

The radial velocity of globular clusters and de Sitter's cosmogony is discussed by L. Silberstein in *Nature*, **113**, 350. A. S. Eddington has a paper on radial velocities and the curvature of space-time in *Nature*, **113**, 746, and L. Silberstein writes on the same subject (*Nature*, **114**, 347).

Miss Vinter-Hansen gives the proper motion of 301 B and M stars in *Ast. Gesell. Leipzig*, 59th year, **3**, 169 and 215.

Theoretical and Special Investigations.—A second paper by A. S. Eddington on the absorption of radiation inside a star appears in *M.N.*, **84**, 104. A note on this subject by S. Rosseland is also in *M.N.*, **84**, 525. J. Woltjer has a derivation of the temperature density relation in Eddington's theory about the interior of a star (*B.A.N.*, **66**), confirming the latter's relation.

The relation between masses and luminosities of stars is the subject of an important paper by A. S. Eddington (*M.N.*, **84**, 308) The absolute magnitude of any giant star, whose mass and effective temperature are known, is determined by the theory of the stellar absorption coefficient. The stars for which these data are known are in good agreement with calculation, though more than half are dwarfs, and it seems that the luminosity of dwarfs is accounted for by their small mass. The behaviour of the stellar substance as a perfect gas at great pressures owing to high ionisation is considered. H. Vogt (*Zs. f. Physik*, **26**, 139) points out that according to this theory either stellar mass remains constant and the Russell diagram does not represent stellar evolution, or if the diagram does represent stellar

evolution the mass must greatly diminish in the process. If this latter be correct, double stars should show, following the Russell diagram, a mean mass relation of brighter to fainter components more and more nearly unity. From investigations of double stars he concludes that the Russell diagram does represent stellar evolution.

Similar considerations are advanced by J. H. Jeans in an investigation of cosmogonic problems associated with a secular decrease in mass (*M.N.*, **85**, 2). He considers the loss of mass by radiation in its effect on the evolution of a double star system and motions in nebulæ.

Sir Oliver Lodge (*Observatory*, **47**, 191) publishes a note on the extra dense gases and other problems connected with Plaskett's massive star and Eddington's theory.

An article on the ages and masses of the stars appears by J. H. Jeans (*Nature*, **114**, 828), in which the effect of loss of mass by radiation is considered.

Scattering and absorption in the atmospheres of emission line stars is dealt with by M. C. Johnson (*M.N.*, **85**, 56). J. Q. Stewart (*Nature*, **113**, 388) discusses Milne's result (*M.N.*, **82**, 368), that the temperature of the outer atmosphere varies from half up to equality with the effective temperature of the surface, and also his deduction of temperature from residual intensity in lines. A reply by E. A. Milne appears in *Nature*, **113**, 534, where it is pointed out that the relative number of suitable atoms, and not the temperature directly, governs the intensity of an absorption line.

Radiative equilibrium of a rotating system of gaseous mass (*M.N.*, **84**, 665), of a slightly oblate rotating star (*M.N.*, **84**, 684) and of a double star system with nearly spherical components, is investigated by H. v. Zeipel (*M.N.*, **84**, 702).

The determination of the masses of stars and the relation between stellar masses as derived from different parallax schemes is discussed by K. Lundmark in the *Vierteljahr. d. Ast. Gesell.* (Leipzig), 59th year, **3**, 203. An article on the masses of the stars, by J. Jackson, is in *The Observatory*, **47**, 92.

A diffusion theory of comets is discussed by H. Macke in *Phil. Mag.*, **47**, 724.

Cosmic clouds of calcium and sodium are explained by B. Gerasimovic (*Nature*, **113**, 458) as balanced by radiation-pressure from B-type stars against gravity. Lines of Na II are not seen because they are scarcely accessible to quartz spectrographs, and the D lines result after recombination.

P. Parchowenko (*A.N.*, **222**, 5236) has an article on inner motions in spiral nebulæ, dealing with the resistance of the medium.

In *Nature*, **113**, 329, is an article by J. H. Jeans on the origin of the solar system, and a letter from Sir Oliver Lodge, 425, on the possibility of formation of a solar system during the act of formation of a double star in the giant stage. Jeans in reply says the evidence is against this hypothesis.

M. Salet writes on the absorbing power of stellar atmospheres in *C.R.*, **178**, 1474.

Convection currents and pressures in stellar atmospheres are investigated by C. E. St. John and W. S. Adams (*Proc. Nat. Acad. Sci.*, **10**, 392, and *Astroph. J.*, **60**, 43). From spectrograms with high dispersion taken at Mount Wilson they find pressures in the atmospheres of Sirius, Procyon, and Arcturus, which are low and comparable with that in the Sun. Relative displacements of arc and enhanced lines are considered and correlated with temperature. Differences in radial velocity show for the high-level lines a prevailing downward motion of the gases. Campbell's hypothesis that convection currents may account in part at least for the K term in B-type stars is supported.

A series of papers by M. La Rosa on a ballistic theory of light and its consequences (*e.g.* in double stars) appear in *Zs. f. Phys.*, **21**, 333, *Ann. der Phys.*, **75**, 195, and in *Nature*, **114**, 933, with rejoinders by W. de Sitter (*B.A.N.*, **57** and **66**), and by C. Nordman and C. Le Mewan (*C.R.*, **179**, 139), and M. G. Sagnac (*C.R.*, **179**, 621).

M. Maggini (*Acad. Lincei.*, **33**, 388) considers the distribution of radiation over the disc of a star determined by the interferometer, and micrometric and interferometer measurements of double stars (*Acad. Lincei*, **33**, 186).

Cosmical refraction is discussed by H. Kienle in *Phys. Zeit.*, **25**, 1, and 306.

The absorption of light in open star clusters is considered by P. Bruggencate (*Zs. f. Phys.*, **29**, 243), who also (*Zs. f. Phys.*, **24**, 48) discusses the vestiges of spiral structure in star clusters.

An article by E. Smith on occulting matter in space appears in *Pop. Ast.*, **32**, 265.

H. Kienle considers (*Zs. f. Phys.*, **20**, 381) the absorption of light and the boundary of star-systems.

Absorption in free space is discussed by A. Kopff (*Zs. f. Phys.*, **23**, 411).

A paper on the electrical state of a star is published by S. Rosseland (*M.N.*, **84**, 720).

C. Parvalesco (*C.R.*, **178**, 375) writes on the constitution of groups of stars. In *L'Astronomie* there is a series of articles on the Cepheids by F. Henroteau (pp. 285, 334, 369).

In *Nature* (**113**, 402) there is an account of a paper by E. A. Kreiken on the distances of stars in the Scutum group and other galactic regions.

P. Stroobant and P. Bourgeois in *L'Astronomie* write on certain stars whose movement is parallel and equal to that of the Sun.

A note on Vegard's theory of the aurora is given by R. d'E. Atkinson (*Proc. Roy. Soc.*, **106**, 429), and J. C. M'Lennan and G. M. Shrum write on the luminescence of nitrogen, argon, and other condensed gases at very low temperatures (*Proc. Roy. Soc.*, **106**, 138)

The luminescence of solid nitrogen and the auroral spectrum is discussed by L. Vegard (*Nature*, **113**, 716 and **114**, 715), and the light emitted from solidified gases and its relation to cosmic phenomena in *Nature*, **114**, 357.

The light of the night sky is investigated by Lord Rayleigh by analysis with colour filters, and its intensity variations determined

(*Proc. Roy. Soc.*, **106**, 117). Its intrinsic brightness and spectral components are studied by J. Dufay in *Journ. de Physique*, **5**, 57, S.

M. G. Sagnac writes (*C.R.*, **179**, 437) on the true classification of double stars.

Statistical Investigations.—W. J. Luyten finds (*P.A.S.P.*, **36**, 86) observed velocities of some stars belonging to the Hyades cluster agree closely enough with computed values to favour physical connection with the cluster.

A note on some statistical consequences of the luminosity law appears by W. J. Luyten (*Proc. Nat. Acad. Sci.*, 1924, 260), and in *H.C.O. Circ.*, 262, in remarks concerning recent work on the luminosity curve, he disagrees with Seares (see below), and compares the data and methods used.

A second paper on the Magellanic Clouds, by Harlow Shapley, in *H.C.O. Circ.*, 260, gives the luminosity curve for the giant stars. Jeans' and Lundmark's interpretations are considered. A paper on the distribution of the stars by H. Shapley appears in *Pop. Ast.*, **32**, 418. *H.C.O. Bull.*, 796, contains an account of contrasted galactic concentration of A and F stars, in which a rapid decrease in the average absolute brightness, with advancing type, is shown.

The distribution of absolute magnitudes is investigated by K. G. Malmquist (*K. Svenska vertenskap Handlinger*, 3rd series, Bd. 1, No. 2), who brings out the excess of dwarf over giant stars.

A series of articles by F. H. Seares deal with the luminosity and density functions in great detail. In the *Astroph. J.*, **59**, 11, discrepancies between observed and calculated distributions are considered, also the relation of Strömberg's result that the solar motion varies with the brightness of the reference stars. Luyten's conclusion, based on large proper motions, that M_0 must be increased, is invalidated by selection in the data discussed. A further paper on the form of the luminosity function is in *Astroph. J.*, **59**, 310. Mean parallaxes of stars of small proper motion are investigated in *Astroph. J.*, **60**, 175.

The Sun's motion and the mean parallaxes of stars of different apparent magnitudes is discussed in *Astroph. J.*, **60**, 50, where a relation between solar speed and brightness of reference stars is given agreeing with Strömberg's investigation. The distribution function for stellar velocities is investigated in *Astroph. J.*, **59**, 274, where numerical values of the moduli of the distribution functions are given and the mean tangential velocity. Various properties of the Gaussian error function are collected.

G. Strömberg (*Astroph. J.*, **59**, 228) discusses the asymmetry in stellar motions and the existence of a velocity restriction in space, indicating that the distribution of stellar motion is determined by two connections, one with the local system and another with a very large cosmical system.

J. Schilt writes on the distribution of the *c* stars (*B.A.N.*, 48).

J. H. Oort (*Proc. Nat. Acad. Sci.*, **10**, 256) has a paper on a possible relation between globular clusters and stars of high velocity, and on p. 253 a note on the difference in velocity between absolutely bright and faint stars. Greater percentages of high velocity stars occur among the fainter stars.

H. Shapley and A. J. Cannon publish a summary of a study of stellar distribution in *Proc. Am. Acad.*, **59**, 9.

A paper on a general relation in stellar statistics appears by A. Kohlschutter in *A.N.*, **220**, 5269.

A series of papers under the title "A Statistical Discussion of Sets of Precise Astronomical Measurements," appears in *Proc. Nat. Acad. Sci.*, **10**, by E. B. Wilson and W. J. Luyten.

o Ceti.—A. H. Joy (*P.A.S.P*, **36**, 290) describes the spectrum of the close companion. It is probably B type, containing emission lines. The bright hydrogen lines and the broad helium lines belong to the companion.

W. J. S. Lockyer records spectroscopic and magnitude observations during 1924 in *M.N.*, **84**, 558.

Measures of the companion are published by R. G. Aitken in *P.A.S.P.*, **36**, 296. D. H. Menzel (*H.C.O. Circ.*, 258) states that *o* Ceti is found to be probably cooler than the early M stars, and that its atmosphere is considerably rarefied. As the light of the star decreases, emission lines appear, in order of decreasing ionisation potential. No element of I.P. less than 7·4 volts gives emission lines.

M. La Rosa considers the constitution of a variable of the type of Mira in *Accad. Lincei*, **33**, 3.

Wave-Lengths.—H. D. Babcock (*Phys. Rev.*, **24**, 205) in an abstract announces new preliminary values for selected lines in the red and green, averaging ·008A and ·003A respectively, smaller than the adopted values.

W. F. Meggers and C. C. Kiess publish (*Sci. Pap. Bur. of Standards*, No. 479) international measures of long wave-length in the iron arc, and in *Sci. Pap. Bur. of Standards*, No. 478, a redetermination of secondary standards from the new international iron arc.

W. F. Meggers (*Astroph. J.*, **60**, 60) discusses standard wave-lengths and regularities in the iron arc spectrum. The combination principle affords tests of the accuracy of measures of certain standard lines. Lines easily shifted by pressure and pole effect are seen to originate in transitions from outermost orbits. The use of an iron arc *in vacuo* is advised as a source of secondary and tertiary standards.

R. E. Harriss (*Astroph. J.*, **59**, 261) investigates the pole effects and pressure shifts in the lines of zinc and cadmium. Pole effect is observed in the copper arc by F. Simeon and E. S. Driblow (*Nature*, **114**, 751). H. C. Crew (*Astroph. J.*, **60**, 108) gives a list of wave-lengths in the vacuum arc of titanium from λ3653 to λ6366 with a discussion of Rowland and Littrow grating mountings: 700 known and 78 new lines are listed. The infra-red spectra of zinc and cadmium are given by H. M. Randall and W. N. St. Peter in an abstract (*Phys. Rev.*, **23**, 766, A, 21). E. O. Hulburt (*Phys. Rev.*, **24**, 129) lists absorption lines in the spectrum of the metallic spark in water for twenty elements between 4500 and 2500A.

Measures of the vacuum spark spectrum of zinc are announced by R. A. Sawyer in the *Phys. Rev.*, **23**, 760, A, 20 from λ2100 to λ4000.

A. S. King publishes (*Astroph. J.*, **59**, 155) the furnace spectrum of Ti from λ2600 to λ3883, giving the temperature classification of

785 lines including many of Ti II, which latter are suppressed by the admixture of potassium.

H. G. Gale and G. S. Monk (*Astroph. J.*, **59**, 125) publish measures of the line spectrum of fluorine from λ3400 to λ7800 and approximate wave-lengths of heads of ten bands of fluorine between λ5100 and λ7000.

J. A. Anderson (*Astroph. J.*, **59**, 76) publishes his measures of the vacuum spark spectrum of calcium between λ2000 and λ6600. A logarithmic scale of intensities is introduced using the method of exposure ratios. A direct wave-length reader is described for measuring grating spectra. About 800 new lines are listed.

In *Zs. f. Phys.*, **26**, 102, E. Freundlich and E. Hochheim discuss the origin of the so-called cyanogen band at λ3883. It does not appear in their apparatus when only nitrogen is present but does if carbon is present also.

W. Watson (*Astroph. J.*, **60**, 145) investigates the emission spectrum of water vapour. A new band at λ3021 is measured in addition.

A new volume of Kayser's *Handbuch der Spectroscopie* is published, including all available data up to the date of publication on the elements up to iron, in alphabetical order of atomic symbols.

A letter by Robertson (*Nature*, **113**, 926) on the comparison of wave-lengths with a Fabry and Perot *étalon* is replied to by H. D. Babcock (*Nature*, **114**, 276), who points out an error in the former letter. J. A. C.

*General Spectroscopic Investigations.**

Band-Spectra.—Series relations in the band-spectrum of *Hydrogen* are traced by H. S. Allen (*Proc. Roy. Soc.*, A, **106**, 69). The band-spectrum of *Nitrogen* is investigated by R. T. Birge (*Phys. Rev.*, **23**, 294). A new band-spectrum in *Carbon Monoxide* is announced by F. Baldet (*L'Astronomie* 1924, 444). The band-spectrum of *Mercury* and the dissociation of hydrogen molecules by excited mercury atoms is discussed by K. T. Compton and L. A. Turner (*Phys. Rev.*, **48**, 360), while a new band-spectrum of mercury and the origin of the mercury band-spectrum is investigated by M. E. Hultin (*C.R.*, **179**, 528). R. S. Mulliken (*Nature*, **114**, 349) has a note on the band-spectrum of Boron monoxide, and on a band probably due to *Calcium Hydride* (*Phys. Rev.*, **23**, 768, A, 28).

R. C. Johnson writes on ultra-violet emission bands associated with *Oxygen* (*Proc. Roy. Soc.*, A, **105**, 683). In *Proc. Roy. Soc.*, A, **106**, 174, the band-spectra of *Silicon Oxide* and *Chloride* and *Chlorides* of *Carbon*, *Boron*, and *Aluminium* are investigated by W. Jevons.

A new *Hydrocarbon* band (λ3143) is announced by R. Fortrat (*C.R.*, **178**, 1272). Some molecular absorption spectra of *Hydrocyanic acid* are dealt with by E. F. Barker (*Phys. Rev.*, **23**, 200). Series in the absorption spectra of *Water vapour* are detected by H. Witt (*Zs. f. Phys.*, **28**, 249).

* This account does not aim at completeness, but supplements the section on the theory of spectra and high temperature ionisation with papers on spectroscopy of general interest to astrophysicists.

The secondary spectrum of *Hydrogen* is investigated by O. S. Duffendack (*Phys. Rev.* **23**, 123, A, 10, and *Astroph. J.*, **60**, 122).

H. G. Smith (*Proc. Roy. Soc.*, A, **106**, 400) investigates the fine structure of band-spectra of *Sodium*, *Potassium*, and their *mixed vapours*.

The *negative Nitrogen* spectrum is investigated by M. Fassbender (*Zs. f. Phys.*, **34**, 73) and the *second positive Nitrogen spectrum* by E. Hulthen and G. Johansen (bands at λλ3536, 3755, 3805), *Zs. f. Phys.*, **26**, 308, by P. Lindau (*Zs. f. Phys.*, **26**, 343 and **30**, 187), and by R. Mecke and P. Lindau (*Phys. Zeit.*, **25**, 277). Systems in band-spectra are investigated by R. Mecke in the *Zs. f. Phys.*, **28**, 261. M. Ferrières investigates the ultra-violet absorption of *Ammonia* (*C.R.*, **178**, 202).

Series in Line-Spectra.—The spectrum of *Iron* has been attacked and many classifications made; some results are included under high temperature ionisation (*supra*). O. Laporte classifies multiplets in the iron spectrum in *Zs. f. Phys.*, **23**, 135, and **26**, 1; and S. Goudsmit extends his own work in *Nature*, **113**, 604, and gives term names of some multiplets in the iron spark in *Proc. Amst. Acad.*, **27**, 572. The structure of the iron spectrum is also investigated by H. Gieseler and W. Grotian (*Zs. f. Phys.*, **25**, 165).

In the spectrum of *Manganese* S. Goudsmit (*Nature*, **113**, 238) finds a D^1 level greater than the largest known P term, indicating a possible metastable state. The spectrum of *Silicon* at successive stages of ionisation is described by A. Fowler (*Nature*, **113**, 802), and R. A. Sawyer (*Phys. Rev.*, **23**, 108, A 14) mentions new members in the series of Si IV.

N. K. Sur finds (*Nature*, **114**, 611) regularities in the spectrum of *ionised Titanium*.

Series in *ionised Carbon* are given by A. Fowler (*Proc. Roy. Soc.*, A, **105**, 299).

A possible singlet series is arranged in the spectrum of *ionised Aluminium*, by H. N. Russell (*Nature*, **113**, 163).

F. J. v. Wisniewski discusses the *p* and *d* terms of *Lithium* in *Phys. Zs.*, **25**, 330.

A new combination series in *Helium* is announced by J. S. Foster (*Phys. Rev.*, **23**, 293, A 18).

F. L. de Bruin and P. Zeeman discuss the spectrum of *ionised Potassium* in connection with the red and blue spectrum of *Argon* (*Nature*, **114**, 352).

M. F. Croze writes (*C.R.*, **179**, 1603) on the structure of the spectrum of *Nitrogen*.

The structure of the spectrum of ionised *Nitrogen* (N II.) is investigated by A. Fowler (*Proc. Roy. Soc.*, A, **107**, 31). The classified lines lie between λ3000 and λ4000. The highest term is a *p* term, and the value of the ionisation potential found by Miss Payne (*H.C.O. Circ.*, 256), and by R. H. Fowler and E. A. Milne (*M.N.*, **84**, 506), yields plausible values for the series terms.

E. O. Hulburt deals with the Balmer lines of *Hydrogen*, and extends the series in absorption to the tenth line (*Phys. Rev.*, **23**, 107, A 8, and **23**, 593, A 9).

R. A. Millikan and I. S. Bowen give lines and term values in *Boron, III.* (*Proc. Nat. Acad. Sci.*, **10**, 199); *Beryllium, II.*; and *Carbon, IV.* (*Nature*, **114**, 380).

J. J. Hopfield (*Astroph. J.*, **59**, 114) finds new series of triplets in *Oxygen* in the extreme ultra-violet, and suggests two metastable forms of oxygen. Resonance and ionisation potentials of stable atomic oxygen are calculated as 9·106 and 13·56 volts respectively.

A symposium on the spectra of the lighter elements appears in *Nature*, **113**, 217, by J. C. M'Lennan, R. A. Millikan, A. Fowler, N. Bohr, and others.

New Spectra and Remeasurements.—The arc spectra of metals *in vacuo* (Zn, Ca, K, Mg, Cu, Al) and in different media (Mg, Ca, Zn, Cd, Hg) are investigated by S. Procopiu (*Ann. de Physique*, 10th series, **1**, 89).

The spectra of *Lithium* and *ionised Lithium* are discussed by M. Morand (*Journ. de Physique*, v., **96**, S, and *C.R.*, **178**, 1701 and 1897); and by F. L. Mohler (*Phys. Rev.*, **23**, 108, A 13), who finds evidence of a spark line at λ2934·15.

Messrs. Ruark, Mohler, Foote, and Chenault give spectra and critical potentials of the *fifth group of elements* in *Sci. Pap. Bur. of Standards*, 490.

The spectra and higher spark spectra of *Argon*, *Krypton*, and *Xenon* are investigated by L. and E. Bloch and G. Déjardin in *C.R.*, **178**, 1069; *Ann. de Physique*, **11**, 461, and including *Mercury* in *Jour. de Physique*, 1924. The spark spectrum of *Cæsium* is given by L. A. Sommer (*Ann. der Physik*, **75**, 163), and that of *Potassium* by W. Dahmen (*Zs. f. Phys.*, **29**, 264).

Pole lines occurring in the interrupted arc spectra of *Silver*, *Copper*, and *Gold*, are tabulated by H. Lowery (*Phil. Mag.*, **48**, 1122). J. Lunt writes (*M.N.*, **85**, 38), on the spectrum of *Germanium*.

Absorption Spectra. — The absorption spectra of mixed metallic vapours are investigated (usually for Na and K) by S. Barrat (*Nature*, **114**, 827), and by A. L. Narayan, D. Gunnaiya *et al.* (*Proc. Roy. Soc.*, A, **106**, 51; *Phys. Rev.*, **23**, 46, and *Nature*, **114**, 194). The absorption spectra of *Vanadium*, *Titanium*, and *Scandium* are presented by H. Gieseler and W. Grotrian in *Zs. f. Phys.*, **25**, 342, and of *Chromium* and *Iron* in *Zs. f. Phys.*, **22**, 245. The absorption spectrum of the *Cadmium* spark in water (lines of Cd. I. and Cd. II.) has been found by H. Stuckler (*Zs. f. Phys.*, **30**, 24).

The absorption and dispersion of *Thallium* vapour is investigated by A. L. Narayan, D. Gunnaiya, and K. R. Rao (*Proc. Roy. Soc.*, A, **106**, 596).

A. Ll. Hughes and F. E. Poindexter deal with the absorption of *Helium* radiation by helium (*Phys. Rev.*, **23**, 769, A 31).

The absorption spectrum of *Sulphur* is investigated by V. Henri and C. Leves (*C.R.*, **179**, 1156, and *Nature*, **114**, 894).

Selective absorption by luminous *Mercury* vapour is described by E. P. Metcalfe and B. Venkatesachar in *Proc. Roy. Soc.*, A, **105**, 520.

G. R. Harrison (*Phys. Rev.*, **24**, 466) investigates series limit absorption in *Sodium* vapour, and finds densitometer curves for the

sodium principal series, and for the *Hydrogen* diffuse series absorption in stars, show great similarity near the limits.

Special Investigations.—The origin of certain lines (twenty-one in all), hitherto attributed to oxygen, is traced to Deslandres' carbon bands (*Phil. Mag.*, **47**, 586) by W. Jevons.

T. Takamine and M. Fukuda describe (*Nature*, **114**, 382) the excitation of the line λ2270 of *Mercury* which is forbidden by the selection principle. The continuous spectrum of *Hydrogen* is the subject of several papers by A. Carst (*Ann. der Physik*, **75**, 665); H. B. Lemon (*Nature*, **113**, 127, and **113**, 570); O. W. Richardson and T. Tanaka (*Nature*, **113**, 192); and F. Horton and A. C. Davies (*Nature*, **113**, 273).

A note on Zeeman effect in strong magnetic fields appears in *Nature*, **114**, 273, by P. Kapitza and H. W. B. Skinner.

Stark effect on fundamental series is noted by T. Takamine in *Nature*, **114**, 433, and in *Hydrogen* and *Helium* by J. S. Foster (*Phys. Rev.*, **23**, 677).

The optical parts of the Victoria spectrograph are described by J. S. Plaskett (*Astroph. J.*, **59**, 65). An apparatus for broadening spectra is described by W. J. S. Lockyer (*M.N.*, **85**, 47).

A. A. Michelson gives preliminary results and a description of his method for determining the velocity of light (*Astroph. J.*, **80**, 256).

Intensity relations in the helium spectrum are the subject of a paper by C. B. Bazzoni and J. T. Lay (*Phys. Rev.*, **23**, 327).

Theoretical.—D. R. Hartree (*Proc. Roy. Soc.*, A, **106**, 552) investigates the relations between optical spectra of different atoms of the same electron structure.

G. Déjardin discusses (*Ann. de Physique*, **11**, 241) the spectra of monatomic gases.

The relative probabilities of the transitions involved in the Balmer series are calculated by F. C. Hoyt (*Phil. Mag.*, **47**, 826).

A note on the constitution of spectra by W. M. Hicks is published in *Phil. Mag.*, **48**, 307.

G. Mie in an investigation of the radiation of light by excited atoms (*Ann. der Physik*, **73**, 195) finds that experimental observations are explained equally well either on the assumption of a finite time of occupancy of the upper quantum state and instantaneous transitions, or by assuming the transition time finite and the duration zero.

J. A. C.

Double Stars.

Measures and New Pairs.—An important double-star publication during the year was a volume of double-star observations made by the late Prof. E. Doolittle at the Flower Observatory. It contains about 4000 measures of 1300 stars, mostly neglected pairs of early discovery or pairs of very recent discovery. The volume was published by the Flower Observatory as a companion volume to Prof. Doolittle's earlier volume. The work was edited by Dr. Aitken.

The Greenwich annual volume for 1920 contains the measures of such

stars as were observed at least three times between 1919 and 1923. There are in all about 230 stars, including many β and Σ pairs.

R. G. Aitken has found no appreciable change in the position of the companion of o Ceti (*P.A.S.P.*, **36**, 296).

H. A. Alden (*A.J.*, 837) has published observations of a distant physical companion to γ Ceti.

B. H. Dawson has continued his work on double stars at La Plata and has found 47 new double stars, all under 5″ separation, mostly between $-29°$ and $-36°$. They are for the most part faint, and the mean measures for several nights are given in *A.J.*, 834.

T. E. Espin and W. Milburn have published the results of another year's observations in *M.N.*, **84**, 162. The measures relate to 57 miscellaneous stars, the new doubles E 2007–2078 mostly between 35° and 39° declination and M 276–322 mostly between 61° and 69°. There are also measures of a few other pairs which have not been numbered. 47 of the new Espin stars and 32 of the Milburn stars have a separation under 5″.

C. Luplau Janssen has given the measures of 69 double stars of over 2″ separation, observed at the Urania Observatory in *A.N.*, **222**, 65. The measures of 28 others are given in *A.N.*, **222**, 283.

R. Jonckheere has continued his work on recently discovered double stars. In *A.J.*, 838, he has published the measures of 135 double stars discovered since 1905. The measures were made at Lille and Greenwich. The list contains 11 new double stars, J 1348–1358.

H. Krumpholz has given in *A.N.*, **222**, 7, the measures of 84 double stars, mostly Σ stars of 1″ to 5″ observed with the 12-inch Clark refractor at Vienna. Half of them were observed on 1 night only ; many of these are fairly close.

J. H. Pitman (*Pop. Ast.*, **32**, 227) has published a note on 28 double stars photographed at the Sproul Observatory. The average magnitude difference is only $0^m{\cdot}3$, the separation is generally under 4″ and goes down to 1″·76. The exposure times ranged from 3^s to 9^m.

H. Scholl has measured 124 double stars, mostly Σ of 3″ to 30″ separation, with the 19 cm. refractor at Bad Tölz (*A.N.*, **221**, 297).

Orbit Determinations.—The only new orbits published during the past year were :—

	P.	*a*.	*e*.	
β 416	42·2 years	1″·83	0·55	J. Voûte, *B.A.N.*, 70.
ψ Argus	34·90 ,,	0·914	0·37	B. H. Dawson, *A.J.*, 843.

Miscellaneous Notes.—A considerable number of short notes have been published. J. H. Moore and R. G. Aitken (*P.A.S.P.*, **36**, 326) discuss the relation between periods and eccentricities, and the masses of binary stars. For both spectroscopic and visual binaries the generally recognised increase of eccentricity with period is clearly brought out.

Spectroscopic Binaries.		Visual Binaries.	
Average Period.	Average Eccentricity.	Average Period.	Average Eccentricity.
2·7 days	0·05	16·8 years	0·43
7·6 ,,	0·16	37·1 ,,	0·40
14·1 ,,	0·22	73·0 ,,	0·53
30·6 ,,	0·35	138·0 ,,	0·57
102·5 ,,	0·30	274·3 ,,	0·62
1177 ,,	0·31		

Up to 100 days it is found that eccentricity increases more rapidly with the period for early than for late type stars. Giants and dwarfs show little difference in the period-eccentricity relation. The conclusions as to the masses are summarised as follows: (1) The masses of systems whose spectra are of Class B exceed many times those whose components belong to other spectral classes. (2) Giant pairs among visual doubles are in general more than three times as massive as those whose components are dwarfs.

J. Hellerich (*A.N.*, **220**, 249) has discussed the masses and mass ratios for spectroscopic double stars and found that the relative masses of the components may be much more different than is generally supposed. E. B. Wilson and W. J. Luyten have also considered the mass ratio for binary stars but more from the point of view of deviation from a mean (*Pop. Ast.*, **32**, 626).

In an investigation on the loss of mass by double stars through radiation, H. Vogt concludes (*Zs. f. Phys.*, **26**, 139), from the mass ratio for the components, that the Russell statistical diagram of spectral type and absolute luminosity indicates the actual course of stellar evolution, and consequently from Eddington's researches that there is a large loss of mass with age.

The masses of stars as determined by Seares, Jackson, and Adams Russell and Joy is summarised by Jackson (*Observatory*, **47**, 92).

J. H. Oort has investigated the average velocities of visual and spectroscopic binaries of different types but found that these do not differ much from the average values for single stars of the same types. He has also found that the average radial velocity of late type stars with B or A type companions was exceptionally small (*Pop. Ast.*, **32**, 226).

J. Weber (*A.N.*, **220**, 189) has discussed the difference of the Einstein effect on the components of double stars and deals specially with the companion to Sirius.

C. Luplau Janssen and S. Fjeltofte have determined the hypothetical parallaxes of 7 double stars (*A.N.*, **222**, 31) and three others (*A.N.*, **222**, 285).

S. A. Mitchell has discussed the system of 9 Argus and found a mass of 12 times the Sun's mass by using the best trigonometrical parallax (*Astroph. J.*, **50**, 201).

W. S. Adams and A. H. Joy (*P.A.S.P.*, **36**, 142) have found a spectroscopic parallax of 0″·31 for ϵ Indi as compared with 0″·47 found by Shapley and 0″·28 found trigonometrically by Gill.

P. Doig (*B.A.A. Journ.*, **34**, 17) and F. C. Leonard (*B.A.A. Journ.*, **34**, 107, 108) have discussed the spectral parallaxes for ϵ Lyræ and θ Orionis

A. Prey from a long discussion of the observations of 70 Ophiuchi has concluded that the observations cannot be satisfactorily explained by elliptic motion. The orbit is not closed, after a complete revolution, the distances being systematically smaller (*A.N.*, **220**, 273).

J. Haas (*Observatory*, **47**, 376) draws attention to the fact that the Greenwich Observations of Capella in 1900 agree fairly well with the orbit deduced from the Mt. Wilson interferometer observations.

M. Brendel (*A.N.*, **222**, 337) has proved and applied Gauss' formula for the theoretical frequency of double stars.

A. Wilkens has determined the mean positions of 658 double stars from meridian observations at Breslau, epoch about 1921 (*A.N.*, **222**, 337).

R. G. Aitken has intimated that the Card Catalogue of all double-star observations is up to date, and that the preparation of a printer's copy is about to be undertaken (*Pop. Ast.*, **32**, 542). J. J.

*Variable Stars.**

General.—The year has seen the publication of a few volumes of particular interest to variable star workers. Foremost among these is the second volume of *Die Veränderlichen Sterne*, by J. Stein, under the auspices of the Specola Astronomica Vaticana, containing an account of mathematical and physical investigations of variability. The appearance of the ninth *Report of the B A A. Section for the Observation of Variable Stars*, covering the period 1915–1919, and the annual *Report of the American Association of Variable Star Observers* for 1923, should also be mentioned. An account of the work accomplished by the Association Française d'Observateurs d'Etoiles Variables is contained in the *Report of the Director of the Observatory of Lyons* for 1923.

The *Astronomische Nachrichten*, *B.A.A. Journ.*, *Bull. Ast. Inst. Neth.*, *Harvard Bulletin*, and *Monthly Notices* contain, as usual, particulars of a large number of investigations of a more or less routine character. These are not mentioned here individually unless they show features of special interest.

The A.G. Commission for Variable Stars announces in *A.N.*, 5331, the names, positions, and magnitudes of 203 recently discovered variables. Positions of several variables are given by the Engelhardt Sternwarte in *A.N.*, 5332, and by the Hamburg Sternwarte in *A.N.*, 5336.

In *A.N.*, 5266, 5271, and 5306, H. Ludendorff continues his investigations of variables, chiefly of the long-period and irregular classes. Miss A. J. Cannon records observations of 59 new variables in *Harv. Circ.*, 265, and in *Harv. Circ.*, 266, S. I. Bailey discusses variables in the

* Owing to unforeseen circumstances, the preparation of this note could not be begun in time to allow of the thoroughness originally intended. An attempt has been made to preserve the comprehensiveness of the survey, but the descriptions of individual researches are necessarily only of the most general character.

cluster N.G.C. 6723. The *Union Obs. Circ.* (*Johannesburg*), No. 61, gives, on p. 233, observations and light-curves of several variables near the large Magellanic Cloud.

In *P.A.S.P.*, **36**, 137, W. S. Adams, A. H. Joy, and R. F. Sanford give a list of 44 variables showing variable velocity which have not previously been announced. On p. 225 of the same volume appears a note by P. W. Merrill on the variable B-type star H.D. 161114, the spectrum of which shows bright hydrogen lines and 70 bright lines in the blue and violet, including a very pure *enhanced* line spectrum of iron.

S. Aurino discusses the photometric variations of X and T Cancri in *Accad. Lincei Atti.*, **32**, ii., 483, and those of R Leonis, RX Virginis, and R Virginis in **33**, i., 17, of the same publication.

In *A.N.*, 5314, G. Zacharov comments on the step method of estimating visual magnitudes, and gives the results of his observations of a few variables. E. Perepelkin (*A.N.*, 5316) discusses a method of observing variable stars similar to that of Pickering, and gives some results of its practical application.

β Lyræ and Eclipsing Variables.—In *M.N.*, **84**, 629, Miss M. A. Blagg presents and analyses 1220 observations of β Lyræ made by Baxendell during a period of more than thirty-eight years R. A. Rossiter (*Ap. J.*, **60**, 15), in a spectrographic study of β Lyræ, shows that the velocity of the centre of mass of the system is constant, and that probably no third body exists since elliptic motion is well established. There is a secondary oscillation of the spectrum lines, however, which is attributed to an effect of rotation of the brighter component during eclipse.

E. E. Markwick (*B.A.A. Journ.*, **35**, 52) discusses observations made by several observers in former years of nine Algol-type variables, with a view to determining accurate elements of the variability.

Michcovitch (*Comptes Rendus*, **178**, 74) discusses the space distribution of 152 eclipsing variables, and finds them concentrated to the galactic plane, though not to the same extent as the B- or N-type stars.

In *Contributions from the Princeton University Observatory*, No. 7, R. J. McDiarmid gives the results of a detailed photometric study of TV, TW, and TX Cassiopeiæ, T Leo Min., and SS Camelopardalis

Vol. 2 of the *Bull. Ast. Inst. Neth.* contains several investigations of eclipsing variables. In No. 58 J. Stein has a note on Fetlaar's revised method for determining the elements of ellipsoidal stars of this type, and J. Fetlaar and A. A. Nijland give observations and discussions of several such stars. Provisional elements of 26 new eclipsing binaries in the η Carinæ region are given by E. Hertzsprung in No. 65, and in No. 68 J. Schilt discusses the light-curve of SW Lacertæ.

In *Journ. Roy. Ast. Soc. Canada*, 1924, p. 339, F. Henroteau discusses the variable σ Cygni, which is probably of Algol type. The mean density is about 0·0003 compared with the Sun (spectral type, B8p), and the deduced characteristics of the secondary component suggest those of a planet rather than those of a star.

Union Obs. Circ. (*Johannesburg*), No. 60, contains, on p. 221, a discussion and evaluation of period of a peculiar Algol-type variable in

Cor. Aust. In *A.N.*, 5270, S. Blazko points out that the period of WW Cygni undergoes a periodic change.

Cepheids.—In *A.N.*, 5301 and 5318, J. Hopmann presents and discusses observations of colorimetric intensity and effective temperature of seven Cepheids, made with Wilsing's colorimeter. The curve of temperature change is shown in some instances to lie closely parallel to the light-curve, except that it appears to show a secondary maximum and minimum on the descending branch. The apparatus and methods of investigation are described in *A.N.*, 5283. The following conclusions are arrived at:—(1) Cepheids have, in relation to their spectral type, very low effective temperatures. (2) They have decidedly larger mean radii than that deduced by Eddington from his pulsation theory. (3) There is a temperature change corresponding to the change in spectral type. (4) The bolometric magnitude has a very small amplitude of variation, so that the total energy received from the star is almost constant. (5) The changes of radius appear to be much greater than those predicted by the pulsation theory. The general conclusion is drawn that the pulsation theory in its present form does not agree with observation.

Changes in period, etc., of Cepheids have been the subject of a number of investigations. In *P.A.S.P.*, **36**, 82, A. H. Joy studies the change of period of SW Andromedæ. J. H. Moore and E. A Kholodovsky (*P.A.S.P.*, **36**, 211) announce variations in several of the elements of Polaris, assuming that the short-period variation is due to the orbital motion of Polaris in a binary system. No change of period is detected. B. Gerasimovic, however (*Ast. Journ.*, No. 839), regarding Polaris as a Cepheid, investigates an alleged long-period variation in the position of Polaris which would indicate a binary character for the star. He finds no evidence of such a variation. S. Blazko (*A.N.*, 5278) finds a periodic change of period of RW Draconis; and J. Hellerich (*A.N.*, 5306), in an investigation of the period of η Aquilæ from considerations of its median magnitude, finds fresh evidence of a lengthening of period—by about 24^s per century. The general question of the *periodic* change of period of Cepheids from the standpoint of the pulsation theory is discussed by B. Gerasimovic (*A.N.*, 5290), who suggests as a possible cause a variation of the "polytropic index" k, which is defined by the relation $p = \text{const.}\ \rho^k$, where p and ρ are the pressure and density in the star.

B. Lindblad (*Ap. J.*, **59**, 37), in a comparison of the proper motions and radial velocities of the galactic cluster-type variables, in which account is taken of the distribution of these stars on the celestial sphere, finds support for Shapley's parallaxes for these stars derived from the period-luminosity curve. The peculiar motion of RR Lyræ and RZ Cephei may be ascribed to their situation in the Milky Way near the apex of the motion of our system relative to the cluster-type variables.

Miss Leavitt's observations of RZ Cephei (completed in 1921) are presented by W. J. Luyten in *Harv. Circ.*, No. 261. Apparently the light-variation of this star (whose space velocity is abnormally high) does not follow a constant curve.

E. Hertzsprung (*Bull. Ast. Inst. Neth.*, 2, Nos. 54, 56, 63) discusses a number of Cepheids, including those in the η Carinæ region, which it is reasonable to assume form a connected group with approximately equal parallaxes. He finds, however, no conspicuous relation between period and apparent brightness. F. Henroteau (*Journ. Roy. Ast. Soc. Canada*, 1924, p. 339), led thereby to a similar study of the Cepheids in the region of the star clouds of Sagittarius, finds that there also no relation is evident between period and apparent brightness, but that there is evidence of a relation between apparent brightness and spectral type.

J. Schilt (*Bull. Ast. Inst. Neth.*, 2, No. 48), in a study of the stars showing the *c*-characteristic, finds that Cepheid variation is common among those of later spectral type, and that the space distribution of these stars and of Cepheids is similar.

In *A.N.*, 5290, I. Balanowsky announces that VW Cassiopeiæ, previously regarded as an irregular variable, is a Cepheid with a period of 5·9941 days. W. J. Luyten contributes to *Lick Obs. Bull.*, 11, No. 351, a study of SX Herculis—a doubtful Cepheid.

Long-Period Variables.—In *A.N.*, 5304, W. Hassenstein describes a new system of classification of long-period variables on the basis of the light-curves, and applies it to certain existing data.

In *Harv. Circ.*, 259, Leon Campbell gives a synoptic report on maxima and minima of long-period variables and a few particularly interesting irregular variables for the year 1923. In No. 272 he gives predicted maxima and minima for the year 1925 of 372 long-period variables.

La Rosa (*Accad. Lincei Atti.*, 33, i. 3) maintains that the light-curves of long-period variables can be explained on two hypotheses: (1) that the velocity of light may be compounded with that of its source; (2) that the stars are in general complex stars.

In *Observatory*, **47**, 267, W. M. Smart discusses the radial velocities and other characteristics of long-period variables, and P. Doig contributes a note to the *B.A.A. Journ.*, **34**, 106, on the luminosities and motions of these stars.

P. W. Merrill and S. Strömberg (*Ap. J.*, **59**, 97) discuss the intrinsic luminosities at maximum of long-period variables as derived from trigonometric parallaxes, proper motions, spectrum characteristics, and special features characteristic of particular stars. They derive a mean absolute magnitude of +0·1 for all stars of class Me. The diameters are computed on reasonable assumptions to be about 130 times that of the Sun, and the authors suggest that one or two of these stars might be measurable by the interferometer. The apparent solar speed is found to increase with the average residual stellar velocity—in harmony with previous results for other classes of stars.

S. Strömberg and P. W. Merrill (*Ap. J.*, **59**, 148) compute the three rectangular velocity components of the motion relative to the Sun of 30 long-period variables of spectral classes M and S from the radial velocities, proper motions, and absolute magnitudes. The stars are divided into two groups according to spectra, and show a marked asymmetry in velocity distribution.

In *Ast. Journ.*, No. 838, A. S. Young and A. H. Farnsworth give proper motions of twelve long-period variables.

Mira Ceti has been the subject of several investigations. In *M.N.*, **84**, 558, W. J. S. Lockyer describes spectroscopic and magnitude observations of this star made during the minimum of 1924 January. Observations at three minima are recorded and discussed by A. A. Nijland in *A.N.*, 5262 (see also note in *A.N.*, 5275), with reference to the mean light-curve. In a study of line intensities in stellar spectra (*Harv. Circ.*, 258), D. H. Menzel gives reasons for believing that Mira is cooler than the early M stars. Its atmosphere appears to be considerably rarefied. An unusually low temperature is suggested for the S-type variables also. A. H. Joy (*P.A.S.P.*, **36**, 290) gives the result of a spectroscopic examination of the companion of Mira. It is probably of B type, but its lines are mainly bright. Its absolute brightness cannot be greater than magnitude +6·0, and it appears to be the only white dwarf known which shows bright lines.

In *Harv. Circ.*, 253, Leon Campbell gives a mean light curve and improved value of the period of T Centauri—the star having the shortest period among the long-period variables. In *M.N.*, **84**, 624, P. M. Ryves gives observations of the peculiar variable SS Aurigæ. In *A.N.*, 5340, R. Müller discusses the period, magnitude changes, and spectrum of the long-period variable R Aquilæ, whose period is decreasing.

Irregular Variables.—In *A.N.*, 5294, B. Okounev discusses ρ Cassiopeiæ, which is a semi-regular variable with a period of about 1100 days, an amplitude of 4·4 – 5·1 mag., and variations of brightness generally resembling those of Cepheids, but which is essentially peculiar and unlike anything known previously.

Harv. Bull., 798, contains a discussion of AB Aurigæ, an irregular variable of spectral type A0. Most A-type variables are Cepheids or eclipsing binaries. The variability is suggested as arising from occultations by cosmic dust clouds.

In *Harv. Circ.*, 254, H. Shapley gives observations of the *dwarf* variable stars in the Orion nebula. All other known variables are giants.

P. M. Ryves (*M.N.*, **84**, 171) gives observations of X Herculis, a star whose variability was in doubt. It appears to be an irregular variable of an interesting type, showing a tendency to conform to a regular period.

Novæ.—W. H. Wright contributes an interesting article to *P.A.S.P.*, **36**, 159, in which evidence is adduced (drawn from the structure of the bright spectrum bands, and not from the line displacements) that novæ are surrounded after outburst by an expanding nebulous envelope. The view that the spectra of novæ become identical with those of Wolf-Rayet stars is confirmed.

In *A.N.*, 5327, N. Barabascheff discusses the phenomena of novæ on the assumption that these bodies are due to an explosion in a star, followed by a pulsation.

Harv. Bull., 797, contains observations of Z Andromedæ, a peculiar variable whose spectrum resembles that of a nova at a certain phase.

The work done at the Union Observatory, Johannesburg, on Nova Aquilæ (1918) at the time of its appearance is described in the *Circular*, No. 62, p. 271. Photographs of the spectrum at different stages and records of the spectroscopic observations are included.

The following records of observations of novæ in their later stages have been published during the year:—

Nova Ophiuchi (1848).	W. H. Steavenson (*M.N.*, **84**, 397).
Nova Cygni (1876).	W. H. Steavenson (*M.N.*, **84**, 397).
Nova Persei (1901).	W. H. Steavenson (*M.N.*, **84**, 538); B. M. Peek (photometric) (*M.N.*, **84**, 541).
Nova Lacertæ (1910).	W. H. Steavenson (*M.N.*, **84**, 397).
Nova Aquilæ (1918).	W. H. Steavenson (*M.N.*, **84**, 397); H. Vogt (*A.N.*, 5272); C. Luplau Janssen (*A.N.*, 5306).
Nova Cygni (1920).	W. H. Steavenson (*M.N.*, **84**, 397); N. Wladimirsky (*A.N.*, 5275); P. Davidovitsch (*A.N.*, 5296); H. L. Alden and others (*Ast. Journ.*, No. 840).

H. D.

Nebulæ.

The measures of the rotation and proper motion of certain spiral nebulæ by Van Maanen are re-examined by W. M. Smart (*M.N.*, **84**, 333). He concludes that the proper motions derived by Van Maanen are probably real and of the right order of magnitude, and he sees no reason to doubt the internal motions found, which are in general of much greater magnitude than the proper motions. The same question is approached from a rather different point of view by J. Jackson (*M.N.*, **84**, 401), as he discusses the influence of the random motion of the comparison stars, which are almost uniformly faint. The conclusion reached is that a reasonable proper motion of the comparison stars will explain most of the total proper motions of the nebulæ, but will not explain away the more interesting and important internal motions.

In *M.N.*, **84**, 456, C. C. L. Gregory deals with the excess of small inclinations to the line of sight found by Reynolds in the case of the planes of spirals of over 2′ angular diameter. The method adopted is to determine the distribution of the poles of these spiral planes. In a great many cases there are, of course, two possible positions of the axis, as we have little or no indication as to which half of the projected spiral plane is nearer to us. By a probability method an attempt is made to free the data from this uncertainty, and the result arrived at is that the poles of the 362 spirals considered are distributed more or less uniformly over the sphere, except in two areas containing the north and south galactic poles, in which they are lacking. The same question had been previously treated for 25 large spirals by Knox Shaw (*M.N.*, **69**, 498) without any definite result, and for 150 spirals by B. Meyermann

(*Ast. Nach.*, Band 219, No. 5240), the latter finding that there was a tendency for the planes to lie parallel with the galactic plane.

In *M.N.*, **85**, 142, J. H. Reynolds draws attention to the nature and spacing of the condensations in the spiral nebulæ which have been discussed by Jeans from the theoretical standpoint in his *Problems of Cosmogony*, p. 217 *et seq.*

An examination of a number of photographs of spirals leads to a division of these objects into "filamentous" and "massive," the former being the nearest approach to Jeans' theoretical form. In the "massive" spirals consisting of an extended nucleus and broad spiral arms, often with a general background of nebulosity, the condensations appear over large areas, and it is difficult to find any average spacing for the nebula as a whole which could be interpreted as a gauge of distance in accordance with Jeans' formulæ. On the other hand, the filamentous class often provide examples of regularly disposed condensations or "beads," which evidently have resulted from the breaking up of a stream of matter. There is, however, a general increase in the spacing of the condensations outwards along the spiral arms, which corresponds with an increased value of the angular velocity and therefore a decrease in line density, in this respect agreeing with Van Maanen's measures. In such objects as M 33 and M 31, grouped condensations appear in the outer regions, which are quite stellar in character on large scale photographs, and these differ greatly from the large nebulous condensations sometimes appearing in the spirals. The conclusion is reached that there is a great variation in the actual size and mass of the spirals if the number and spacing of the stellar condensations be considered.

Although no papers on nebulæ have been published from the Mount Wilson Observatory during the year, work of first-rate importance has been done by E. Hubble on variable stars in the spirals, which it is hoped will soon be available for publication. In *Harvard Annals*, **85**, No. 6, descriptions and positions of 2829 new nebulæ are given, more than 80 per cent. of which are situated in the south galactic hemisphere. The photographs examined were obtained with the Bruce refractor at Arequipa with exposures between 1 and 4 hours. Very few planetary or irregular nebulæ were found, 2733 being classed as spheroidal, spindle, oval and spiral, and therefore probably non-galactic. The percentage of the four classes were 80, 11·9, 7·6, and 0·5 respectively, thus showing that the spheroidal nebulæ greatly preponderate among the fainter southern nebulæ (*vide H.C.O. Bull.*, 808).

The galactic distribution of the brighter and larger examples of the different classes is dealt with by Reynolds in *M.N.*, **84**, 76. While the observational data is necessarily incomplete owing to the absence of information as to the area from $-45°$ to $-90°$, it is found that the small spiral and spheroidal nebulæ correspond in distribution generally with the larger spirals. The tendency to grouping of the spheroidal and ovoid nebulæ is specially remarkable, and the excess of the brighter spheroidal forms found in the south galactic hemisphere over those in the north galactic hemisphere is in agreement with the large numbers of faint spheroidal forms given in the *H.C.O. Bull.*, 808, already mentioned.

In the *Observatory*, **47**, 279, Dr. Knut Lundmark has an article on the "Determination of the Apices and Mean Parallax of Spirals," based on the radial velocities of 43 nebulæ of spiral class given by V. M. Slipher. He derives the apex as :—

$$\begin{aligned} \alpha &= 20^{h}\cdot3 \pm 3^{h}\cdot0 \\ \delta &= +75^{\circ} \pm 30^{\circ} \\ v &= 651 \pm 135 \text{ Km/sec.} \end{aligned}$$

After computing the solar apex from 7 spirals of which the p.m.'s were given by Van Maanen, he concludes that the mean distance of these spirals cannot be less than 30,000, and is perhaps as much as several hundred thousand light years. In the same publication, **47**, 203, appears a photograph of a remarkable planetary nebula (N.G.C. 7635) in Cassiopeia obtained with the Mount Wilson 60-inch reflector, and a short article dealing with this object.

Professor Max Wolf contributes in *A.N.*, 5334, a paper on "The Star Vacancies in the America Nebula and the Comparative Numbers of Stars in the Dark and Bright Parts of the Nebula." An analysis of the stars in the region of ξ Cygni is given, which shows a relatively great absence of the fainter magnitudes in the dark portions of the nebula compared with the unobscured star fields. The difference becomes marked after the 9th magnitude, where the numbers in the three categories of clear, half clear, and obscured areas are equal.

Details are also given of stars up to 16th magnitude on a determined scale of magnitudes, 17th magnitude being added by extrapolation.

In *A.N.*, 5336, appears a paper by C. Wirtz on "The Milky Way, Spiral Nebulæ, and Stars," which is based on Father J. G. Hagen's work on "Obscure Cosmic Clouds," observed visually at the Vatican Observatory. A visual photometric scale for the integrated brightness of the sky background was first determined, and tables are given in which the influence of galactic latitude on stellar and nebular densities is eliminated.

It is found that the fainter the spiral nebulæ the smaller is their concentration towards the galactic North Pole, and they tend to a uniform distribution over the sphere.* The stars up to 11th magnitude and the N.G.C. spiral nebulæ have no obvious relation in their apparent distribution, certainly not in the expected direction that the frequencies of stars and nebulæ are connected. J. H. R.

Mars, 1924.

The opposition of Mars, which occurred on 1924 August 23, was in one respect exceptionally favourable, the distance between the planet and the Earth being reduced almost to its minimum possible value. As a result, the apparent diameter attained a maximum of 25″·1 on

* In this connection the term "spiral nebulæ" is evidently intended to mean the non-galactic nebulæ generally. The results arrived at are not entirely borne out by other recent work on the galactic distribution of this class of nebulæ.

August 22, the date of apparitional perigee, as against 24″·0 at the time of the last really close approach, on 1909 September 18. However, this slight gain in diameter in 1924 was more than discounted, so far as most observers in the northern hemisphere were concerned, by the considerable southerly declination of the planet, whose meridian altitude at the time of opposition was about 13° less than in 1909.

The principal circumstances of the apparition of 1924 were as under:—

Date of opposition	1924 August 23.
Date of apparitional perigee	1924 August 22.
Apparent diameter at apparitional perigee	25″·11.
Position of planet at date of opposition	$\alpha = 22^h\ 19^m$. $\delta = -17^\circ\ 40'$.
Autumnal equinox of N. hemisphere	1924 May 12.
Vernal equinox of S. hemisphere	
Mars in perihelion	1924 August 30.
Winter solstice of N. hemisphere	1924 October 5.
Summer solstice of S. hemisphere	
Position angle of the N. pole of Mars at opposition	349°·8.
Latitude of the centre of the disc at opposition	−16°·25.

The apparent diameter of the planet exceeded 15″ between June 16 and October 26, and an inspection of the above data shows that this period covers the late spring and extends beyond the summer solstice of the southern hemisphere, which latter was the one presented to the earth.

Much of the work known to have been done during the apparition has yet to be published. Indeed, in the case of some of the best-equipped observers it is still unfinished, for the rapidly increasing altitude of the planet in the northern hemisphere has made it possible to obtain useful results even up to 1925 February, in spite of the small apparent diameter. However, some interesting accounts have already appeared in various journals, and brief reference is made to some of these in what follows.

Visual Observations.—The apparition does not appear to have been marked by the discovery of much that is new in the way of fine detail; and, on the whole, the results in this respect are perhaps inferior to those obtained at the similar apparition of 1909. There is general agreement as to the progress of seasonal change in the tone of the principal dark markings. These were universally noted as being very faint during June, July, and early August, after which a gradual darkening set in, reaching a maximum about the time of the summer solstice of the southern hemisphere. Among the few tonal abnormalities observed were the general duskiness of the region immediately preceding the *Syrtis Major*, and the extreme faintness of *Pandoræ Fretum* as compared with its appearance in 1909, when it was of almost as deep a tone as its companion marking, the *Sinus Sabæus*.

There is some disagreement as to the size and rate of melting of the South Polar cap. E. M. Antoniadi, who gives in *L'Astronomie* (1924 July to 1925 February) a full account of his observations with the great

Meudon refractor, remarks that he found the cap abnormally large early in the apparition, and that the subsequent melting took place at less than the average rate. This would seem to support his belief that the size and rate of melting of the cap vary in close accordance with the phases of the solar cycle, a large cap being associated with the epoch of a sunspot minimum (see *M.N.*, **76**, 643). On the other hand, E. C. Slipher, in *Pop. Astron.*, 1924 November, states that the cap was found to diminish in size at about its mean rate, and that even on the photographs, which tend always to exaggerate the extent of the cap by irradiation, the diameter is seen to be less than that reported by Antoniadi.

Some conspicuous rifts and dark patches were observed in the cap, during its melting, by Antoniadi, Phillips, Slipher, and others. Slipher remarks that these features corresponded closely in position, form, and time of appearance with those observed in 1909: in fact, he notes, all changes of an evidently seasonal nature observed in that year appear to have followed the same course in 1924, practically to within a single Martian day.

The appearance of a few temporary bright areas in different parts of the disc, sometimes seen also as projections on the terminator, is reported by E. C. Slipher (*loc. cit.*), G. Van Biesbroeck (*Pop. Astron.*, 1924 December), T. E. R. Phillips (*M.N.*, **85**, 179), and E. M. Antoniadi (*loc. cit.*).

The exact appearance of the finer details of the planet's surface is still a matter of much disagreement among the various observers. Thus G. H. Hamilton (*Pop. Astron.*, 1924 November and December), observing with the 11-inch refractor at Mandeville, Jamaica, draws the "canals" in the style which has come to be known as "Lowellian," and is convinced of the substantial accuracy of the delineations made in former years at Flagstaff. His results appear to be supported, to some extent at least, by the work of R. Trumpler (*Publ. Ast. Soc. Pac.*, 1924 October). This observer, using the 36-inch Lick refractor, depicts "canals" in large numbers in both bright and dark regions of the planet. They are somewhat broader than the fine lines drawn by Hamilton, but their general straightness and continuity are noted as striking features.

On the other hand, G. Van Biesbroeck (*Pop. Astron.*, 1924 December), observing Mars with the 40-inch Yerkes telescope on October 27, when the seeing was extremely good, could see nothing whatever of a linear character on the disc; and this was also the experience of Antoniadi throughout the apparition. F. Baldet, who also used the Meudon telescope, saw no canals. A selection of his beautiful drawings is reproduced in *L'Astronomie* for 1925 January. They show a considerable amount of detail of a mottled or patchy character, and confirm very closely indeed the results obtained by Antoniadi with the same instrument. Finally, F. G. Pease, in the course of a short article on the performance of the 100-inch reflector on lunar and planetary detail (*Publ. Ast. Soc. Pac.*, 1924 December), states that, while an appearance suggesting a linear network is sometimes presented in unsteady air, there is nothing of the kind visible in moments of good seeing. At such times the dark markings were broken up in

places into an intricate and irregular mosaic of fine detail, while in certain regions the structure revealed was similar to that seen on photographs of the central portions of the Orion nebula.

Photographic Studies.—A fine series of photographs, extending throughout the apparition, was obtained by Slipher at the Lowell Observatory, Flagstaff. A selection of these is reproduced in *Pop. Astron.* for 1924 November, and also in *Publ. Ast. Soc. Pac.* for 1924 October. For comparison, a similar series, taken at corresponding Martian dates in 1909, is reproduced by the side of those taken in 1924. The close similarity of the seasonal changes, having regard to date, is very clearly demonstrated by this means.

W. H. Wright, in *Pub. Ast. Soc. Pac.* for 1924 October, gives an illustrated account of some important photographic researches carried out by him with the Crossley reflector of the Lick Observatory. The planet was photographed successively in infra-red, yellow, and violet light, and the resulting images exhibit very striking differences. The infra-red photographs exaggerate the depth of tone of the dark markings, show a falling off of light towards the limb, and make the polar cap smaller and less bright than it is seen usually. The yellow photographs reproduce very closely the visual appearance of the planet, both as regards the dark markings and the polar cap. Most interesting of all are the violet images, which are quite unlike the others. They show little or no trace of the dark markings, but the polar cap appears unduly large and bright. There is no fading towards the limb, and the entire image is noticeably larger than those produced by yellow and infra-red light. Wright concludes from the above data that the planet is surrounded by a considerable though somewhat tenuous atmosphere, about 120 miles in height, and that the violet photographs give a picture of this, and of little else. On the other hand, the infra-red pictures show this atmosphere only by virtue of its absorbing effects, all of the light forming the image proceeding from the surface of the planet. This would naturally be the result, supposing the atmosphere to act, like that of the Earth, by scattering and reflecting light of short wave-length, while readily transmitting the red and infra-red rays. The anomalous appearance of the polar cap on the violet photographs is striking, and suggests to Wright that it is, at least partly, an atmospheric effect, though the existence of a true, but smaller, surface cap is not denied. Incidentally the darkness of the markings on the infra-red photographs confirms the common visual impression that their colour is, in general, a bluish green.

Radiometric Work.—Two important and independent attempts to measure the radiation from the surface of Mars were made in 1924. W. W. Coblentz and C. O. Lampland, whose results are published in *Pop. Astron.* for 1924 November, used a compensated thermocouple on the 40-inch Clark reflector of the Lowell Observatory. Their measures indicate that the equatorial regions are much warmer than the polar, and the dark areas hotter than the bright. The gradual rise of temperature in the southern hemisphere as the summer solstice approached was clearly indicated, the maximum temperature each day occurring in the afternoon, as on the Earth. The general conclusion

reached was that the average temperature for the whole of the illuminated hemisphere was about 280°–290° on the absolute scale, or approximately 45°–65° F.; "about that of a bright cool terrestrial day."

In *Pop. Astron.* for 1924 December, E. Pettit and S. B. Nicholson give the results of a series of similar measures made with vacuum thermocouples on the 100-inch reflector at Mt. Wilson. For the equatorial regions of Mars they deduce a temperature of 280° absolute, for the polar cap 205°, and for the disc as a whole 250°. Unlike Coblentz and Lampland, they do not find the afternoon temperature to be higher than that of the morning, but rather conclude that the maximum occurs exactly at noon. The shape of the diurnal temperature curve suggests an atmosphere of very low density, with a practical absence of water-vapour. W. H. S.

Logarithmic and Trigonometrical Tables.

It is thirteen years since a note on this subject appeared in these reports. That interval has been marked by the appearance of a remarkable group of tables, thoroughly indicative of modern tendencies. They indicate very clearly that progress is being made in two directions, firstly in the adoption of calculating machines by scientific computers, which is made manifest by the publishing of extensive tables of the natural values of the trigonometrical functions. We are now on the road to removing one of the barriers that has stood between computers and the more extended use of mechanical calculators. The second progressive step is the tendency to discard the sexagesimal division of the degree in favour of a decimal division. This reform originated among workers in celestial mechanics, but is bound to spread.

Logarithms of Numbers.—A reprint of Sang's 7-figure tables has been made (London: C. and E. Layton, 1915) from the original stereotype plates. Ten-figure logarithms have become available from two sources, firstly from *Zehnstellige Logarithmentafel* (Erster Band) (Berlin, 1922) produced by the Prussian Land Survey, under the scientific direction of Peters. This has been prepared from the 12-figure manuscript made by Bauschinger and Peters in the course of the preparation of their now well-known 8-figure tables (Leipzig: Engelmann, 1910), and will certainly replace the tables of Vega and of Duffield. The second source of 10-figure logarithms referred to is a photographic reprint (New York: G. E. Stechert, 1923) of the *Thesaurus Logarithmorum Completus* of Vega. The publishers unwisely spared themselves the expense of an editor, so that their reprint has all the errors of the original.

Andoyer, in a 28-page volume of *Tables Logarithmiques à treize Décimales* (Paris: J. Hermann, 1922), gives three tables enabling one to find readily 13-figure logarithms by utilising the principle that the logarithm of a number is equal to the sum of the logarithms of its factors.

The enormous task of producing a table of logarithms to 20 decimals has been undertaken by A. J. Thompson, sponsored by the Biometric

Laboratory of the University of London. The first part of this *Logarithmetica Britannica* (Cambridge: University Press, 1924) has just been announced. A specimen page shows that second and fourth differences are given, so that interpolation may be performed by the use of Everett's Central-Difference formula, for the coefficients of which Thompson has already provided a table (London: Cambridge University Press, 1921).

It is difficult to conceive of any work requiring logarithms to more than 24 places, for which Gray's tables (London: C. and E. Layton) are still available, yet Peters and Stein in a small pamphlet of *Zweiundfünfzigstellige Logarithmen*, published as No. 43 of the *Veröffentlichungen des Astronomischen Rechen-Institut zu Berlin* (Berlin, 1919), give a table for finding 52-figure logarithms. It is not specially convenient, and will doubtless be used only when Gray is insufficient.

Addition and Subtraction Logarithms.—The struggle between the three types of addition and subtraction logarithms, viz. those originated by Gauss, by Zech, and by Bremiker respectively, has resulted in a "survival of the fittest," which has proved to be the Zech type. A new 6-figure table of this type has been published by Cohn (Leipzig: Engelmann, 1909). The final seal of approval of the Zech type is due to Andoyer, whose *Tables Fondamentales pour les Logarithmes d'Addition et de Soustraction* in the *Bulletin Astronomique* (tome ii. fascicule i.) (Paris, 1922) give the values of these functions to 16 decimals with an argument advancing at intervals of 0·01.

Logarithmic Trigonometrical Tables.—Peters in *Fünfstellige Logarithmentafel der trigonometrischen Funktionen für jede Zeitsekunde des Quadranten* (Berlin: Reimer, 1912) has provided an excellent 5-figure table with the argument in time. The reprint of Vega's *Thesaurus* has already been alluded to. This is known to contain some 30,000 or 40,000 errors in the 10th decimal. Andoyer has stated that the error may attain, but does not exceed, 6 units of the last decimal.

Natural Trigonometrical Tables.—The only essentially fundamental tables of the natural values of the trigonometrical functions in existence at the beginning of this century were the *Opus Palatinum* of Rheticus (1596) and the *Trigonometria Britannica* of Briggs (Gouda, 1633). The need for new tables has been met by Andoyer's *Nouvelles Tables Trigonometriques Fondamentales* (*Valeurs naturelles*), published in three large quarto volumes (Paris: A. Hermann, 1915, 1916, and 1918). All six functions are given (two in each volume) to 15 decimals, with their first differences at intervals of 10″. This monumental work will serve as the basis of all smaller tables for many generations—perhaps centuries—to come.

A table by Peters, *Einundzwanzigstellige Werte der Funktionen Sinus und Cosinus* (Berlin: Reimer, 1911), enables 21-figure sines and cosines to be found by an application of the identity

$$\sin(\alpha \pm \Delta\alpha) = \sin\alpha \cos\Delta\alpha \pm \cos\alpha \sin\Delta\alpha.$$

The first attempt to supply a new working table with a sexagesimal argument was Mrs. Gifford's *Natural Sines* (Manchester: Abel Heywood, 1914), giving 8 decimals at intervals of 1″. This has been followed

by a similar volume of *Natural Tangents* (Manchester, 1921). These tables have been produced by interpolating the 10-figure values in the *Opus Palatinum* from intervals of 10″ to single seconds. Although this meritorious single-handed enterprise is somewhat marred by an inconvenient arrangement, nevertheless its appearance in the very year when men met in Edinburgh to celebrate the tercentenary of Napier's invention of logarithms thus helps to sound the death-knell of logarithms and marks an epoch in the era of calculating machines towards which we are now advancing. In the field of 4, 5, 6, and 7-figure tables, however, there remains much work to be done before we can take full advantage of the mechanical aids now at our disposal.

Decimalisation of the Degree.—Lohse's *Tafeln für numerisches Rechnen mit Maschinen* (Leipzig: Engelmann, 1909) is a well-arranged and well-printed table giving the natural values of all six functions at intervals of 0°·01. It is exceptionally convenient for orbital work. A larger table by Peters, *Siebenstellige Werte der trigonometrischen Funktionen von Tausendstel zu Tausendstel des Grades* (Berlin-Friedenau: C. P. Goerz, 1918), gives 7-place values of four functions for every 0°·001. Three new logarithmic tables with an interval of 0°·001, and entitled *Zehnstellige (Siebenstellige und Sechsstellige) Logarithmen der trigonometrischen Funktionen von 0° bis 90° für jedes Tausendstel des Grades* (Berlin, 1919 and 1921), have been produced under the direction of Peters. These give 10, 7, and 6 figures respectively, and, like the sexagesimal tables with which their sponsor has been associated, have been derived by interpolation of Briggs' *Trigonometria Britannica.*

Collections of Tables.—Only two of these call for special comment. The *Tavole Logarithmiche a cinque cifre Decimali* (Genoa: Instituto della R. Marina, 1922) gives 5-figure logarithms, and logarithmic and natural trigonometrical functions with both sexagesimal and time argument. A 4-figure table of exceptional merit is Desvallées' *Tables Logarithmiques et Trigonométriques a quatre Décimales* (Paris: Gauthier-Villars, 1919). It contains logarithms, antilogarithms, addition and subtraction logarithms, and trigonometrical tables with sexagesimal, decimal, and time arguments. L. J. C.

Mention should also be made of the following tables:—H. Brandenburg, *Siebenstellige trigonometrische Tafel für Berechnung mit Rechenmaschine* (Leipzig: A. Lorentz, 1923), which have been specially constructed for the German manufacturers of calculating machines. The natural sines, tangents, cotangents, and cosines are given to 7 decimal places for every 10 seconds of arc, with separate tables of cotangents from 0° to 6° or tangents from 84° to 90°. Such 7-figure tables have long been needed, but tables with the decimal division of the degree are also required. G. M.

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